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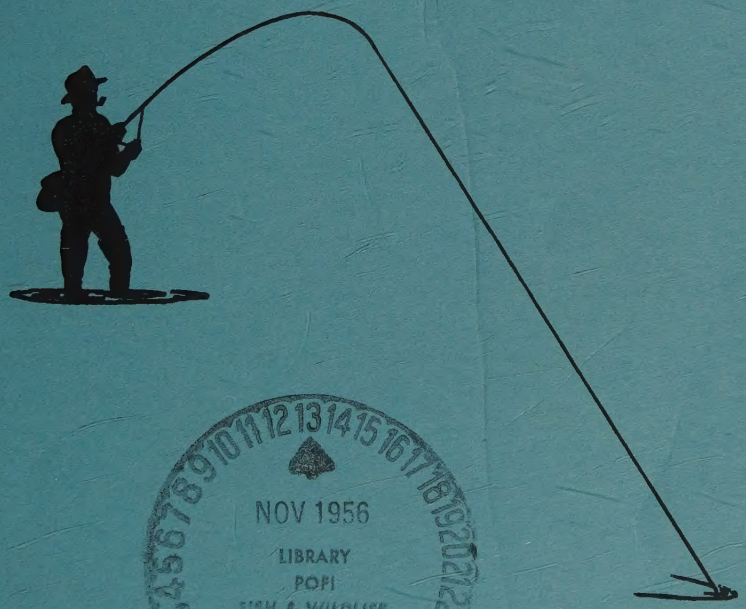
# Sport Fishery Abstracts



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**Abstracts 447-583**

**July 1956**

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# Sport Fishery Abstracts

**An abstracting service for fishery research and management**

Vol. 1, No. 4 Abstracts 447-583 July 1956

Sport Fishery Abstracts is intended to furnish fishery biologists in government agencies and educational institutions with abstracts of the current literature in sport fishery research and management. Abstracts of papers on limnology, ecology, natural history and other fields of specialization will be included when the subject has application to the conservation of sport fish and the restoration of sport fishing.

The symbol (A) following an abstract indicates an author's abstract. Other initials following the abstract are those of abstractors whose names are listed on page 177. If no symbol is given the abstract was prepared by the Editorial staff. The abstracts are numbered serially through the four numbers of each volume. The numbers will be issued irregularly, with a limit of four per year. Each number contains separate Author and Subject indexes.

The first number of each volume contains a list of publications regularly reviewed for suitable abstracts. The succeeding numbers contain any additional publications covered. Suggestions for additional material are solicited in order to obtain as wide a coverage as possible.

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Prepared in the Branch of Federal Aid
Robert M. Rutherford, Chief
William R. Beckmann, Editor
Geraldine C. Ewing, Asst. Editor

SPORT FISHERY ABSTRACTS

Additional Publications Reviewed For Abstracts

Western Fisheries

Papers of Institute of Freshwater Research, Fishery Board of Sweden

Pan American Fisherman

Tidewater News

Biometrika

New Mexico Game and Fish Bulletin

Proceedings of the Gulf and Caribbean Fisheries Institute

447. Barlow, John P. 1955. PHYSICAL AND BIOLOGICAL PROCESSES DETERMINING THE DISTRIBUTION OF ZOOPLANKTON IN A TIDAL ESTUARY. The Biol. Bull., Vol. 109, No. 2, Oct., pp. 211-224.

The zooplankton of a small estuary, Great Pond, located near Woods Hole, Massachusetts, is described. It is shown that in the summer there were endemic populations of several zooplankton of which the copepod Acartia was the most numerous and widespread.

The rates at which Acartia must have been replaced to maintain its numbers in the surface mixed layer of Great Pond in face of dispersion by the tidal exchanges have been calculated. These rates are compared with the rates at which Acartia increased or decreased when isolated in bottles immersed in the pond.

This comparison shows that in the most landward parts of the pond the population in the mixed layer could not reproduce fast enough to maintain itself and was dependent on recruitment from the deeper layer. In the central part of the pond reproduction alone was sufficient to offset the seaward transport by the tidal exchanges. In the most seaward parts of the pond, mortality was so great that the small population was maintained only by transport from the landward parts of the pond. Thus, the comparison reveals the contribution of reproduction, growth and mortality and of tidal transport to the maintenance of the observed distribution of Acartia. Seasonal changes in these physical and biological processes account for the seasonal changes in the distribution of zooplankton in Great Pond.

448. Hargis, William J., Jr. 1955. MONOGENETIC TREMATODES OF GULF OF MEXICO FISHES. (Part I. THE SUPERFAMILY GYRODACTYLOIDEA). The Biol. Bull., Vol. 108, No. 2, April, pp. 125-137.

The series of papers of which this is the first installment deals with the monogenetic trematodes which were recovered from 313 individual fishes representing 25 families. In all, a total of 637 fishes of 98 species were examined throughout the study, but only 49 of these species carried the parasites to be reported in this series. When finally completed, a total of 75 species of Monogenea belonging to over 46 different genera will have been considered. The present paper presents data on several species belonging to the subfamilies Gyrodactylinae and Tetraonchinae.

449. Stephens, Grover C. 1955. INDUCTION OF MOLTING IN THE CRAYFISH, CAMBARUS, BY MODIFICATION OF DAILY PHOTOPERIOD. Biol. Bull., Vol. 108, No. 2, April, pp. 235-241.

During the winter months, crayfishes maintained at moderate water temperatures (approximately 15° C.) responded to daily illumination by an increased tendency to molt. The strength of this tendency to molt increased with increasing length of the daily period of illumination. If there is a threshold below which this response does not occur, it lies below a daily period of illumination of approximately ten and one quarter hours per day. There is an increase in mortality in groups exposed to various daily photoperiods with the highest mortality occurring in animals exposed to the longest light period. This is true of animals which fail to show any sign of the initiation of molt at the time of death.

450. Anonymous. 1954. CANADA'S HIGHEST FISHWAY. Trade News (Dept. of Fisheries, Ottawa, Ont., Canada), Vol. 6, No. 7, Jan., p. 12.

The highest fishway in Canada is located on the Tobique River in Victoria County, N. B. The Tobique River flows into the St. John River, 200 miles (320 km.) from the sea and is the main spawning tributary for Atlantic salmon. The fishway permits the ascent of fish over a height of 80 feet (24.4 m.) and is 1,170 feet (357 m.) long and 8 feet (2.44 m.) wide. It is built up of concrete and starts at the power house and leads the fish in easy stages up a winding course to the spawning beds up-river. There are 4 manually operated entrance gates at the lower end and water conditions in the tailrace of the power station determine which gate should be opened to provide easy access for the fish. Partitions along the fishway break the force of water and create pools thereby helping the fish in their ascent. There are large pools located at each of the 4 turns of the fishway and the fish can rest in these pools in a minimum of 5 feet (9.52 m.) of water. The workability of this fishway has been proved in actual practice. Even sucker, a fish of sluggish movements, passed readily up the fishway; with salmon, an active fish, the results were highly successful. A fish counter showed that over 4,600 salmon found their way safely to the spawning grounds during 1953. It is expected that this fishway will furnish additional data on the upstream migration of fish past high dams. (G.N.S.R.)

451. Koch, W. 1953-1954. CONTROL OF ASCENDING FISH ON THE FISHWAY OF KEMBS IN SUMMER 1944. (a). Archiv für Fischereiwissenschaft, Vol. 4, P. 110, 16 pp. illus. In German. NEW FISHWAY AT STAMP FALLS SAVES VALUABLE SALMON RUNS. (b). Western Fisheries, Vol. 48, No. 4, July, p. 36. In English.

(a). This investigation deals with the fishways of Kembs, at the lowest dam of the Rhine River, near Basle, Switzerland. The most recent fishway built in 1942 is described in detail. It has a length of about 200 m. (656 ft.) and begins 75 m. (246 ft.) before the barrage on the Alsatian side of the Rhine. The new fishway has been tested for the spring and summer ascent of fish. In March and April, only a small number used the way upwards. During the second half of May, when the water temperature increased to more than 13° C. (55.4° F.), there was a greater migration. The highest numbers ascending occurred in July. After this period, the migration decreased. In accordance with the results found in other important fishways of the Rhine and the Neckar, the migration was decisively influenced by a number of factors such as temperature, water level, rate of flow and cloudiness of the water. Spawn migrations are not so frequent as usually thought. The

fishway is used by nearly all species of fish in the river (Salmo salar, Salmo fario, Thymallus vulgaris, Perca fluviatilis, Cyprinus carpio, Tinca vulgaris, Barbus fluviatilis, Chondreostoma nasus, Anguilla vulgaris, Squalius cephalus, Squalius leuciscus, Abramis brama, Blicca Björkna, Leuciscus rutilus, Scardinius erythropthalmus, Gobio fluviatilis, Alburnus lucidus, Alburnus bipunctatus), except pike and pikeperch. The excellent results found in well built fishways should give rise to their construction in every dam on streams (rivers) important to fisheries.

(b). A new fishway at Stamp Falls on the west coast of Vancouver Island, B. C., Canada, is planned in 2 units, referred to as the upper and lower fishways, with connecting link in the center. When water velocity makes it impossible for fish to negotiate any part of the falls they will enter the system through the lower fishway. This will be in tunnel form practically throughout its entire length of 125 feet (38.1 m.). An open section comprising 25 ft. (7.6 m.) of connecting fishway will take the salmon into another tunnel 85 ft. (25.9 m.) in length which, with another open section in the form of a double rectangle, constitute the upper fishway. At certain stages of low water, salmon are able to ascend the lower part of the falls by way of the natural river channel, and will then enter the fishway by way of the center link and proceed through the upper fishway only. On the tunnels and open fishways, the velocity of the water will be checked by a series of vertical slot baffles set in concrete supports at the walls and on the floors of the fishway. Throughout its length a total of 37 baffles will be installed, 11 of these in the lower fishway and 26 in the upper. Height of baffles will vary according to floor levels, but fisheries engineers estimate they will average 15 ft. (4.6 m.). Although concrete will be used in supports and pillars, timber stop logs will form part of the baffles. These will be set at intervals of 10 ft. (3 m.) and the design is calculated to form eddies at these intervals so that fish can rest when necessary in traversing the length of the fishway. Access to the tunnels and fishways will be possible at normal water stages, and at low water maintenance crews will be able to clean and repair them and make any necessary adjustments. (W.P.)

452. Schultz, F. H. 1956. TRANSFER OF ANAESTHETIZED PIKE AND YELLOW WALLEYE. The Canad. Fish Culturist, Issue 18, March, pp. 1-5.

Five lots of 20 yellow pikeperch each were anaesthetized in a solution of 3 to 5 percent urethane until fully relaxed. They were then packed ventral surface up in two layers surrounded with chipped ice. Each box was exposed to air for periods of 1, 2, 3, 4, and 5 hours. Fish in each box were marked before being revived in a holding pen. With a water temperature of 3.5 to 4.5°C. recovery time varied from 5 to 75 minutes for fish exposed to air for 1 hour to a period of 1 to 30 minutes for those exposed for 5 hours. Recovery was 100 percent for all but the fish exposed for 5 hours which had a recovery of 90 percent.

Three lots of 20 northern pike each, handled in the same manner, were exposed for 3, 4, and 5 hours. Recovery was 100 percent for each of the three boxes of fish. Recovery time in 40°C. water varied from 2 to 45 minutes for the lot exposed for 3 hours to 1 to 20 minutes for that exposed for 5 hours.

With such success, 387 anaesthetized adult yellow walleye packed in ice were transferred from Heart Lake to Sandy Lake, a distance of 40 miles. All fish were out of water for periods of less than two hours. Losses amounted to 15 percent. Though not excessive, such losses were not anticipated on the basis of the previous experiments. It is believed that the temperature reduction from the 10.5°C. lake water to a medium near freezing might have been the cause. Temperature reduction of only 3.5 to 4.5°C. was experienced in the earlier experiments.

453. Svardson, Gunnar. 1955. SALMON STOCK FLUCTUATIONS IN THE BALTIC SEA. Annl. Rep. for the Year 1954 and Short Papers, Inst. of Freshwater Res., Rep. No. 36, Fishery Bd. of Sweden, pp. 226-262.

A tendency toward parallel trends in the yields of salmon fisheries of Great Britain, Norway, the Netherlands, and Sweden has been noted for some time. The fact that trends were not parallel every year in these distant areas suggests that climate is responsible. Analysis of data on ice conditions in the Baltic Sea and salmon yield in Swedish rivers for periods of over 80 years provides a statistically significant positive correlation at the 0.002 level between the area of ice cover and the salmon yield five years later. Another peak in salmon yield two to three years after a mild winter was also noted. This correlation was probably due to the effect of high sea temperatures in the spring on the salmon run; more salmon run during a warm spring giving a higher yield the same or following season, and growth acceleration due to warm temperatures results in a greater proportion running in the next few years. A cold spring preceding a warm spring accentuates these effects. It was found that the annual temperature conditions in the sea and rivers give a fluctuating salmon yield by means of "smolt classes" and "spawning classes," which do not parallel the ordinary year classes. This is believed to be the biological foundation for the correlations mentioned above.

A set of hypotheses is given according to which transformations in fish, whether from non-migratory to migratory or from unripe to ripe conditions, can be explained. A trigger mechanism where a temperature stimulus is the releasing factor acting only during a certain sensitive period, fixed by photoperiodism, is involved in all cases. The threshhold of reaction declines with the advancing physiological age of the fish.

The variations in salmon yield caused by temperature fluctuations were found to be accentuated by the effect of severe winters on salmon predators. A slight effect may be obtained in freshwater but the

main effect is in the sea, due to interference with the common porpoise, a species which is very sensitive to hard winters and has repeatedly suffered great losses in winter. An inverse relation between the practice of porpoise hunting and salmon yield is apparent.

454. Bodola, Anthony. 1956. THE LIFE HISTORY OF THE GIZZARD SHAD, DOROSOMA CEPEDIANUM (LESUEUR), IN WESTERN LAKE ERIE. Dissertation Abstr., Vol. 16, No. 3, March, p. 599.

Lake Erie is the heaviest producer of commercial fishes, on a unit area basis, of all the Great Lakes. Recently the possibility has been recognized that much of this lake's productive potential is being passed through fish species not desirable in our commercial markets. One of these species is the gizzard shad. Large numbers of shad are increasingly evident in Western Lake Erie. It seems timely to learn the ecology of this species here so that future management may be possible.

During the years 1952 to 1955, some 30,000 gizzard shad have been collected and studied. The fish were aged, sexed, weighed, and measured. Scale measurements were taken, ovaries were weighed, and "stomach" contents were analyzed. Histological sections were prepared, showing maturation of shad eggs and the seasonal appearance of ovaries. Gut development is shown by camera lucida drawings. A simplified nomographic method of back-calculating fish length from scales is included.

The gizzard shad in Western Lake Erie spawns from May to July, inclusive. The age-group II shad have a longer spawning period than have the age-group I shad or the age-group III or older. Males and females spawn for the first time in their third year of life (90 percent), a few spawn earlier, a few begin later. Shad older than three years often show degenerated ovaries. Eggs which are not spawned are absorbed. Spawning occurs mostly in shoal water. The young, which hatch in from 36 hours to four or five days, were first collected during the latter part of June. The orderly sequence of foods consumed according to age is as follows: protozoans, then zooplankters, and finally an indiscriminate filtering of the water of zooplankters and phytoplankters and various kinds of debris and mud. Sand is also ingested, undoubtedly from the lake bottom. Most rapid growth in length occurs during their first year of life, while that in weight occurs during their second year. Compensatory growth is clearly evident—the younger of the age-group I fish overtaking the larger members of that group by the fourth year of life. The shad form their first annulus during the last week of May. Most of them form their second or later annulus during the last week of June and the first week of July. Fish lengths calculated from scales agree well with the lengths of captured fish at similar ages. The shad at Western Lake Erie were found to grow faster and to a greater length and weight than they do elsewhere, as noted in the literature--though perhaps they die earlier. The oldest shad collected were age-group VI fish (only 3). Egg counts indicate that the individual shad spawns from about 200,000 to 500,000 eggs per season. The ovary attains a peak weight for 500-600 gram fish, with lighter and heavier fish giving lower ovary/body weight ratios. The precocious age-group I female shad produces about 20,000 to 100,000 eggs. She spawns in late July. (A)

455. Anonymous. 1954. MAN-MADE SPAWNING STREAM. Trade News (Dept. of Fisheries, Ottawa, Ont., Canada), Vol. 7, No. 4, Oct., p. 3.

Describes a new, artificial spawning stream that has been built to accommodate spawning salmon in a tributary of the Fraser River, B. C., Canada. The artificial spawning creek is 1,854 ft. (565.1 m.) long with a bottom width of 10 ft. (3 m.) throughout its length. It is adjacent to Jones Creek, a natural spawning stream which was rendered untenable for spawning salmon when a hydro-electric power unit was built in this area, 10 miles (16 km.) southeast of Hope, B. C., Canada. A dam above the creek was built to store the water for the power generators with the result that the water supply to the lower reaches of Jones Creek, where pink and chum salmon spawn and the fry spend their first weeks of life before migrating to salt waters, was reduced to a trickle. To save these valuable commercial salmon runs, an artificial stream bed was built alongside the old Jones Creek. An equivalent spawning area is provided but water flow is less than in the original stream bed. This is offset by more efficient utilization of the smaller flow through control. Floods, which still occur in the area, and which formerly were apt to cause considerable damage, will now be passed down the old channel and thus will not affect salmon eggs deposited in the artificial creek. In the new spawning area, a controlled flow of water will be maintained at spawning and nursery periods; thus, fish will have a far better chance of survival than in the natural stream, where water conditions were uncontrollable. Water is supplied to the artificial creek from the reservoir area behind the main power dam, and enters the new creek bed through a short length of pipe, having been diverted at this point by a small dam. The way was cut through second growth timber and thus the new spawning creek is provided with the shade required by spawning salmon. Gravel, necessary for spawning fish, was added after careful selection of the most suitable size, and spread evenly along the stream bed. (G. N. S. R.)

456. Anonymous. 1954. ADVANTAGES IN DRUGGING FISH. Pan American Fisherman (Orange, Calif.), Vol. 8, No. 8, March, p. 4.

The use of sodium amytal, a hypnotic-type barbiturate, in transporting live fish in tanks has been reported by the California Department of Fish and Game, Berkeley, Calif., U.S.A. This is said to provide several advantages: in a state of narcosis the fis use less oxygen, and therefore need less water in transit. Where planting crews formerly carried 200 fingerlings to the gallon of water, the new system enables them to carry an average of 500 or more. A solution of 1/2 grain of sodium amytal/

gal. (7 mg./l.) of water is said to reduce the amount of water necessary to only 1/3 or 1/4 of that normally required. Fish planting costs are expected to be cut in almost the same proportion. One of the important advantages of the use of the drug is that it increases the temperature tolerance of the fish. This is especially important where the fish are to be moved from water of colder temperature to that of warmer temperature, or where the temperature of the water in the transporting tank is allowed to become somewhat high. As soon as the fish are liberated, the small amount of drug in their system becomes diluted by fresh water and they immediately swim away. The possible use of sodium amytal on salt water fish is being investigated. It is hoped that it can be used in collecting live marine specimens for scientific use and aquarium display, for tagging, and for transporting bait fish. (R.C.S.)

457. Denyes, H. Arliss and Jeanne M. Joseph. 1956. RELATIONSHIPS BETWEEN TEMPERATURE AND BLOOD OXYGEN IN THE LARGEMOUTH BASS. J. Wildlife Mgt., Vol. 20, No. 1, Jan., pp. 56-64.

Measures of the physiological response of the northern largemouth bass to various temperatures were taken to ascertain the degree of adaptation of the bass to its environment. These measures include hemoglobin, red-cell count, arterial blood oxygen, oxygen capacity and lactic acid. Experiments were conducted in the field and in the laboratory where conditions were controlled. At high body temperatures during quiescence, hemoglobin increases in the gills, opercular pulse rate increases, and lactic acid level rises. In blood taken from bass kept at various temperatures increased lactic acid is accompanied by a lower percentage loss of oxyhemoglobin. (A)

458. Brown, Paul Lopez. 1955. THE BIOLOGY OF THE CRAYFISHES OF CENTRAL AND SOUTHEASTERN ILLINOIS. Dissertation Abstr., Vol. 15, No. 10, Oct., p. 1933.

Little attention has been given to the biology of the crayfishes of Illinois during the past four decades. In 1912, Rietz submitted a thesis which was based largely on collections and records of other collectors; it was entitled "Ecological Relations of the Crawfishes of Illinois." Cralley (1932) studied the crayfishes of Champaign County, and Van Deventer (1937) worked out the life-history of Orconectes p. propinquus, while Bovbjerg (1952) contributed a study on the comparative physiology and ecology of this species and Cambarus fodiens.

This investigation was begun in 1952, and during 1953 and 1954, 410 collections were made in the Sangamon, Wabash, and Ohio river basins of central and southeastern Illinois. These collections came from 45 counties. Field notes were made on the physical aspects of the habitats. The crayfish showed varying degrees of specificity as related to the types of bottoms, turbidity of the water, and the types of habitats. The fossorial habits of each form are discussed. Data were compiled on the aquatic habitat, and an attempt was made to correlate the specificity of habitat with the chemical condition of the water as reflected by the limnological data which were compiled at 85 percent of the collecting stations. The data on the temperature of the water suggest that crayfish living in ponds have a wider range of tolerance to changing temperatures than those living in lotic situations. The data on the hydrogen-ion concentrations were inconclusive. The evidence indicates that low dissolved oxygen tensions could be limiting factors for forms which normally live in lotic waters. Likewise these data also indicate that high concentrations of dissolved carbon dioxide could serve as limiting factors for crayfish that normally live in lotic environments. Further investigations on the total alkalinity of the waters inhabited by crayfish might show that the alkalinity of the water serves as a limiting factor for some crayfish.

Notes were made on the vegetation found at the collecting stations; none of the plants seemed to exhibit specificity in their associations with the crayfish. Likewise, the crayfish associates were noted, and a number of the crayfish were associated with many of the other species and sub-species. Life-history notes were made on the observations which were made in the field; these data are summarized in chart form. An attempt was made to correlate ecological factors such as competition, habitat, and the physiographic features of the basins with the distribution of certain of the species and sub-species within Illinois.

A summary of the present status and the disposition of all of the crayfish which have been reported from Illinois is given. It is believed that 16 species and sub-species occur in the State. Fourteen species and sub-species belonging to four genera were collected. Of the 14, one was an undescribed species and three were new records for the State. In the taxonomic section a discussion of the diagnostic characters is given; a description of each of the 14 species and sub-species is included. Two types of taxonomic keys are included as an aid in determining the species and sub-species of both the males and females of the crayfish which were collected in central and southeastern Illinois during this investigation.

459. Hamilton, James Arthur Roy. 1955. AN INVESTIGATION OF THE EFFECT OF BAKER DAM ON DOWNSTREAM MIGRANT SALMON. Dissertation Abstr., Vol. 15, No. 10, Oct., p. 1934.

The effects of a hydroelectric plant and dam 250 feet high on seaward-migrant sockeye salmon (Oncorhynchus nerka) and coho salmon (O. kisutch) were investigated in 1951 and 1952 at Baker Dam in Western Washington. The objectives of the investigation were: one, to determine the character of the downstream migration from the reservoir; two, to determine the effect of the spillway and turbines on the survival of the seaward migrants; three, to evaluate the cause or causes of any existing mortality. The principal method consisted of sampling the native sockeye and coho seaward migrants with fyke nets located in the tailrace below the powerhouse and in the river below the spillway. The fyke-net catches

revealed that over 95 percent of the sockeye and coho migrants leaving the reservoir used the surface spillway exit and that less than 5 percent left through the tunnel, the intake of which was submerged 85 feet at full reservoir. It was concluded from the fyke-net studies that 64 percent of the native sockeye and 54 percent of the native coho died as a result of injuries sustained while passing down the spillway when one spillway gate was open. The turbines killed 34 percent of the native coho under full load conditions. Two supplementary methods applied to sockeye provided confirming results. The adult return of marked seaward-migrating sockeye released over the spillway, into the tunnel and into the river below the dam established a spillway mortality of 63 percent and a turbine mortality of 37 percent. Further confirmation of the effects of the hydroelectric structure and dam was provided by the decline of 55 percent in the sockeye run since the dam was constructed. Most of the injury and mortality to the seaward-migrating salmon was caused by abrasion on the spillway and pressure changes and cavitation in the turbines and on the spillway. It was concluded that a dam of this type has a very detrimental effect on the downstream migrants and that the spillway is responsible for the major part of the mortality.

460. Combs, Bobby D., David D. Palmer, John H. Finucane, and Roger E. Burrows. 1955. TESTS OF HATCHERY FOODS FOR SALMON, 1953 AND 1954. U.S. Dept. of Interior, Fish & Wildlife Serv., Spec. Sci. Rpt. - Fisheries No. 160, Aug., 8 pp.

Feeding trials were conducted at the Salmon-Cultural Laboratory (Entiat, Wash.) during 1953 and 1954 using chinook and blueback salmon as the test animals.

One excellent diet for chinook salmon fingerlings utilizing 25 percent each of hog liver and arrow-toothed halibut (Atheresthes stomias) and 50 percent salmon viscera as a substitute for the more expensive meat viscera diets was developed during the 1953 feeding trials.

The 1954 blueback salmon feeding trials were designed to develop virus-free rations. Several diets devoid of salmon viscera, the suspect carrier, were tested and found satisfactory.

The 1954 chinook experiments were designed to study diets containing 50 percent of dry meals. No satisfactory high-meal diet was produced from these trials. (A)

461. Elling, Carl H. and Paul T. Macy. 1955. PINK SALMON TAGGING EXPERIMENTS IN ICY STRAIT AND UPPER CHATHAM STRAIT 1950. U.S. Dept. of Interior, Fishery Bull. 100, 40 pp.

Although migration routes of pink salmon (Oncorhynchus gorbuscha) in Southeastern Alaska were generally defined as the result of tagging experiments in the 1920's and 1930's, a more critical examination of the racial composition of the various runs was needed. During the summer of 1950, 17,400 pink salmon were tagged in Icy Strait and Upper Chatham Strait to determine the timing and composition of the runs contributing to the fishery in those areas.

Recoveries of fish tagged in Icy Strait confirmed the findings of preceding experiments. Pink salmon were found to disperse easterly through Icy Strait, south into Chatham Strait, and then east and north into Frederick Sound and Stephens Passage. Smaller groups proceeded to Lynn Canal and Peril Strait. There was little movement to westerly areas of Chichagof Island and into and beyond Summer Strait.

Recoveries of salmon tagged in Upper Chatham Strait showed a predominant southward movement through Chatham Strait, an easterly and northerly movement into Frederick Sound and Stephens Passage and a northward migration toward Icy Strait.

Extensive stream recovery of tagged fish suggests that pink salmon bound for Stephens Passage, Chatham Strait, and Icy Strait streams passed through Icy Strait at about the same time. Icy Strait races were in evidence from July 25 to September 5, Upper Chatham Strait races from August 1 to September 5, and Stephens Passage races from July 25 to August 30. Recoveries from Upper Chatham Strait taggings of August 20 to September 3 were concentrated in Chatham Strait streams. A few recoveries were made in Stephens Passage, Frederick Sound, and Peril Strait. (A)

462. Talbot, Gerald B. 1954. FACTORS ASSOCIATED WITH FLUCTUATIONS IN ABUNDANCE OF HUDSON RIVER SHAD. U. S. Dept. of the Interior, Fishery Bull. 101, 40 pp.

A study of the Hudson River shad (Alosa sapidissima) was undertaken during 1950 and 1951 as part of a shad investigation carried out by the Fish and Wildlife Service to supply information to the Atlantic States Marine Fisheries Commission for fishery regulation along the Atlantic coast. Catch and effort statistics were obtained for the years 1915 through 1951, from various sources, for the gill-net fishery which catches more than 95 percent of the shad in the Hudson River. A tagging program during 1951 gave estimates of the total shad population entering the river that year. The total run and the escapement (since the catch was known) were then calculated for each year from 1915 through 1950. Age analysis of a sample of the catch of 1950 and 1951 showed that most shad returned as adults to the river at 4 and 5 years of age. Also, about 50 percent of the fish had previously spawned.

It was shown that about 85 percent of the variation in size of the run between 1920 and 1951 could be attributed to the size of the escapement from the fishery. No correlation was found between the size of the run each year and such factors as stream flow, water temperatures, channel improvements, ship traffic, or hatchery operations. No evidence of natural cycles of abundance was found. Catches of Hudson River shad in waters outside the river were shown to be large, and these catches may affect the expected size of the run. Using the methods outlined, the size of run can be predicted 1 year in advance, and by controlling the fishing efforts, the desired number of shad can be allowed to escape so that future

runs can produce maximum sustained yields of shad from this river. (A)

463. Britt, N. Wilson. 1955. STRATIFICATION IN WESTERN LAKE ERIE IN SUMMER OF 1953: EFFECTS ON THE HEXAGENIA (EPHEMEROPTERA) POPULATION. Ecology, Vol. 36, No. 2, April, pp. 239-244.

Unusual thermal stratification was observed in western Lake Erie during the period September 1 to 4, 1953. Oxygen concentrations as low as 0.70 p.p.m. were found near the bottom. Bottom samples collected on September 5, 1953, revealed a total of 465 Hexagenia nymphs per square meter all of which were dead. In 61 bottom collections made over a large area between the Canadian Shore and Catawba Island from September 14 to 26, and on November 13, 1953, the average number of living nymphs per square meter was 44.3. This was much lower than averages found in other years. The stomach contents of the silver chub, Hybopsis storerianus an important forage fish of this area, showed a great reduction in the use of Hexagenia nymphs in September and November 1953, as contrasted with the same period in 1952. The ultimate effects of this short period of stratification may be very complex and may be felt by the whole economy of western Lake Erie. Much depends upon its influence on forage fishes.

464. Fields, Paul E. 1955. FACTORIAL DESIGNS AND THE GUIDANCE OF DOWNSTREAM MIGRANT SALMON AND STEELHEAD TROUT. Biometrics, Vol. 11, No. 4, Dec., p. 508.

This study is a part of the Columbia River Fisheries Engineering Investigation and Research Program sponsored by the North Pacific Division, Corps of Engineers. Probably because of difficulties encountered in rearing anadromous salmon, there was but little basic information about their sensory abilities and their behavior patterns when it suddenly became necessary to find some effective guiding stimulus. The avoiding response to light seemed to offer the most promise of success.

In the first series of factorial experiments, the reactions of a total of 90 different groups of 25 one-year-old silver salmon, each given four trials, was obtained to a light barrier with three angles and three light intensities, in water of four velocities and three depths. In general, the number of fish entering the lighted area was significantly reduced as the angle of the barrier was made smaller, the intensity of the light was increased, and the velocity was decreased. The F for depth was not significant. In a second experiment, the responses of a total of 72 groups of steelhead trout, chinook and silver salmon were compared on two barrier angles, two light intensities, and two water velocities. The findings of the previous experiment were confirmed and the range extended. In addition, a species difference was established with steelhead trout being the most sensitive to light. In a third experiment, the reactions of a total of 48 groups of 50 each of steelhead trout, chinook and silver salmon were compared with respect to chain barriers with two angles, two different spacings and two water velocities. The only significant F was between species.

As the success in guiding has increased, the normality of the data has decreased, making the application of the usual parametric methods more questionable. (A)

465. Chapman, D. G. and R. Pyke. 1955. THE STATISTICAL THEORY OF SOME MIGRATION POPULATION MODELS. Biometrics, Vol. 11, No. 4, Dec., pp. 508-510.

The problem considered is that of estimating the parameters associated with the migration of individuals between two areas. The populations studied are comprised of two classes of individuals. Four mathematical models are presented with requirements for application.

466. Mansueti, R. 1955. LIFE HISTORY OF THE STRIPED BASS IN MARYLAND WATERS. Md. Tidewater News, Vol. 11, No. 9, Feb., Sup. No. 3.

Migration and anadromous habits, spawning season and behavior, feeding and growth, and catch and availability of striped bass in Maryland waters are discussed. The spawning season extends from April through June. Females usually spawn for the first time when four years old (17 inches) while males mature at two years (12 inches). A 3-pound female (18 inches) may produce 15,000 eggs, while a 50-pound female (50 inches) may produce 5,000,000 eggs. The eggs hatch in about two days at a water temperature of about 65° F. Fresh or virtually fresh waters are chosen for spawning.

467. Trama, Francesco B. 1954. THE ACUTE TOXICITY OF COPPER TO THE COMMON BLUEGILL. Notulae Naturae (The Acad. of Nat. Sci. of Phila.) No. 257, Feb. 17, 13 pp.

The past and more recent work dealing with the toxicity of copper compounds to fish is briefly discussed. The acute toxicity of copper depends on the amount of free copper present in the water and is independent of the anion. This amount is governed by the pH of the water; below pH 5.3 all the copper is in solution, but as the pH increases the copper salts precipitate. All physical and chemical characteristics in the test waters were controlled insofar as practicable throughout the 96-hour test period of exposure.

Ninety-six hour survival curves were obtained using the common bluegill, Lepomis macrochirus. The 96-hour $TL_m$ and 48-hour $TL_m$ values were estimated as 0.74 and 0.90 mg. Cu/l., respectively. These median toxicity limit values are the concentrations of Cu at which 50 percent of the fish survived for 96 and 48 hours.

468. Arbel, E. 1955. PREVENTING THE ENTRY OF WILD FISH INTO FISH PONDS. Bamidgeh, Bull. of Fish Culture in Israel, Vol. 7, No. 3, Nov., pp. 60-62.

A trap designed to prevent fish from entering a pond via the water supply is described. Essentially, it consists of a solid bottom box with wire mesh sides through which incoming water filters. Dimen-

sions may be varied to suit particular situations, but the general design contemplates in-flow water falling one to two feet. Its most serious limitation is the need for frequent cleaning when large quantities of filamentous algae, silt, and other debris are present in the water.

469. Mansueti, R. 1955. NATURAL HISTORY OF THE AMERICAN SHAD IN MARYLAND WATERS. Md. Tidewater News, Vol. 11, No. 11, Sup. No. 4, April.

The American shad in Maryland waters ranks second in value and fourth in total poundage among important commercial fishes of the Chesapeake Bay. Fishermen now recognize it also as a sport fish. It is anadromous and believed to have a strong homing "instinct." It spawns mostly in upper tidal waters of the Bay when water temperatures are from 56° to 66° F. An average of 250,000 eggs are produced by a female which hatch in six days when the water temperature is 57° F. A little less than three days are required when the temperature of the water is 75° F. Scarcely 0.4 of an inch when hatched, they grow to two inches by July, three to five inches by October. Most American shad spend their first winter in the ocean, not returning to brackish and fresh water to spawn for 3 to 5 years.

470. Chapman, Douglas G. 1955. POPULATION ESTIMATION BASED ON CHANGE OF COMPOSITION CAUSED BY A SELECTIVE REMOVAL. Biometrika, Vol. 42, pts. 3 and 4, Dec., pp. 279-290.

The possibility of estimating the size of an animal population on the basis of the change of sex ratio following a kill concentrated on one sex has been noted in wildlife studies. The assumptions involved in this method appear to be simpler and more likely to be fulfilled than those underlying other population estimation procedures and it is shown that non-fulfilment of certain assumptions may involve no serious consequences. To be balanced against this is the fact that the amount of information yielded is smaller for the same effort than is obtainable from the more usual method of estimation based on the recapture of marked members of the population. A quantitative comparison is given of the two methods. Some problems of optimum design in the sampling that accompanies a change of composition estimate are considered and some extensions of the procedure studied.

471. Carpelan, Lars H. 1955. TOLERANCE OF THE SAN FRANCISCO TOPSMELT, ATHERINOPS AFFINIS AFFINIS, TO CONDITIONING IN SALT-PRODUCING PONDS BORDERING SAN FRANCISCO BAY. Calif. Fish and Game, Vol. 41, No. 4, Oct., pp. 279-284.

Atherinops, the topsmelt, is the most salt tolerant fish observed living in ponds used for the production of salt by evaporation of sea water.

It lives throughout the year in ponds with a salt content as great as one and one-half times that of ocean water. It has been observed to spawn in salinities double that of the ocean (72 parts per thousand) and to exist in still higher salt concentrations.

In addition to high salinities, Atherinops in the salt ponds must also withstand other environmental extremes, including high summer temperatures (with a great diurnal range), high pH values, and variable concentrations of dissolved oxygen.

472. Trama, Francesco B. 1954. THE pH TOLERANCE OF THE COMMON BLUEGILL. Notulae Naturae (The Acad. of Nat. Sci. of Phila.) No. 256, Feb 17, 13 pp.

Two series of experiments were conducted to determine the pH range tolerated by Lepomis macrochirus. In one series, buffered solutions were used; in the second series, a continuous flow method was used employing a single acid or base. All the buffer systems in which the pH did not vary more than 0.4, the limit of variation set for these experiments, were somewhat toxic to Lepomis macrochirus except for the disodium phosphate-potassium dihydrogen phosphate systems.

In buffered solutions the pH range tolerated without mortality by Lepomis macrochirus was pH 4.67 ± 0.08 using potassium acid phthalate 0.005M, and pH 9.12 ± 0.06 using sodium borate 0.003M. Some adverse physiological conditions were noticed at these limits. The limits using a single acid or base in the continuous flow method were pH 4.00 ± 0.15, HCl 0.00109M, and pH 10.35 ± 0.15 using NaOH 0.000625M. These limits are probably the true pH limits tolerated by these fish. (A)

473. Wales, J. H. and H. Wolf. 1955. THREE PROTOZOAN DISEASES OF TROUT IN CALIFORNIA. Calif. Fish and Game, Vol. 41, No. 2, April, pp. 183-187.

The occurrence, epidemiology, and pathology of three protozoans, Cryptobia borreli, Plistophora sp., and Ceratomyxa shasta, which have been found in rainbow trout and certain other species of fishes in California, are discussed. Their life histories are incompletely known and their full importance in trout hatcheries and in the wild is little understood.

474. Weisel, George F. 1955. VARIATIONS IN THE NUMBER OF FIN RAYS OF TWO CYPRINID FISHES CORRELATED WITH NATURAL WATER TEMPERATURES. Ecology, Vol. 36, No. 1, Jan., pp. 1-6.

Redside shiner, Richardsonius balteatus balteatus, and squawfish, Ptychocheilus oregonense, were studied to determine whether or not within a limited geographic area there existed a correlation between water temperature and the number of dorsal and anal rays. Collections of these species were made at eight sites, all in the Clarkfork River drainage within a 75-mile diameter circle. Physical barriers to population mixing were not present. Average water temperatures at the collection sites ranged from 8.3 to 24.0 degrees Centigrade.

It was found that the average number of anal rays of the shiner is moderately well correlated with

water temperature; fish from the warmer waters having lower counts than those from colder waters. The dorsal rays of the shiner do not relate as well to temperature as the anal rays. The number of dorsal rays of squawfish taken in warm waters is significantly lower than in those taken from colder waters; anal ray counts were found to be of little importance since they were the same for all but two localities. There is a definite tendency in both cyprinids toward a positive correlation between the number of anal and dorsal rays; if few in one fin, there likely will be few in the other. The hypothesis that the numbers of anal and dorsal rays are independent was statistically rejected.

475. DeWitt, Robert M. 1955. THE ECOLOGY AND LIFE HISTORY OF THE POND SNAIL PHYSA GYRINA. Ecology, Vol. 36, No. 1, Jan., pp. 40-44.

Physa gyrina is a typical inhabitant of temporary and permanent ponds. The life history and ecology of this pulmonate snail were studied in three ponds in Michigan. In Scio Pond, a permanent pond located about 8.5 miles northwest of Ann Arbor, Michigan, oviposition occurred in the spring when water temperatures reached 10° to 12° C. The adult population died shortly thereafter. Snails born in the spring reached sexual maturity that fall, but most oviposition was delayed by low temperatures until the following spring. Within the Scio Pond population a shell length of 7 mm. was determined to be the size below which snails are believed to be sexually immature. Those individuals 7 or more millimeters in length were capable of ovipositing under favorable environmental conditions. The life span of individuals in the field was from 12 to 13 months. The life history of P. gyrina in a permanent pond 300 miles north of the above-mentioned habitat differed only in that oviposition took place three to four weeks later in the spring.

Temporary ponds, located in southern Michigan, are usually dry from mid-June until November. Estivation forced upon P. gyrina living in such habitats delayed growth, and the snails rarely attained sexual maturity by the fall of the year in which they hatched. The time of reaching maturity the following spring was dependent upon the length of estivation. If the dry period is unusually long, the snails may overwinter a second year. Thus, the life span in such situations may be considerably longer than in permanent ponds.

476. Koster, William J. 1955. OUTLINE FOR AN ECOLOGICAL LIFE HISTORY STUDY OF A FISH. Ecology, Vol. 36, No. 1, Jan., pp. 141-153.

This paper is another of a series of life history outlines prepared under the sponsorship of the Committee on Life History Studies of the Ecological Society of America. It is especially intended to aid beginning graduate students and is most applicable to the study of North American fresh water fishes. Literature, unit of study, equipment and methods, habitat, capture and preservation of specimens, observations on behavior, food and feeding habits, migration and local movements, reproduction, age and growth, population studies, and mortality and survival are discussed with frequent referencing to pertinent publications. The outline is detailed and comprehensive.

477. Livingstone, D. A. 1955. A LIGHTWEIGHT PISTON SAMPLER FOR LAKE DEPOSITS. Ecology, Vol. 36, No. 1, Jan., pp. 137-139.

A new lake-bottom sampling device has been designed to take an undisturbed and uncontaminated sample of lake bottom sediments. It is light in weight, being constructed of high-strength aluminum alloy, and can be operated by one man. Construction details and several possible improvements not yet tested are described.

478. Vallentyne, J. R. 1955. A MODIFICATION OF THE LIVINGSTONE PISTON SAMPLER FOR LAKE DEPOSITS. Ecology, Vol. 36, No. 1, Jan., pp. 139-141.

A modification of the Livingstone piston sampler is described. The sampler employs the piston feature of the Livingstone device in conjunction with the rod and locking mechanism of the Davis borer. The sampler can be used for loose and compact sediments. Detailed design features of the modified sampler are presented.

479. Aquatic-Life Advisory Committee. 1956. PROCEDURES FOR INVESTIGATION OF FISH-KILLS. Bull. of Ohio River Valley Water Sanitation Comm., Cincinnati, Ohio, March, 24 pp.

This handbook for field reconnaissance and data collection discusses the reasons for and methods of determining fish kills and the importance of making such determinations as soon as possible after reports of die-offs are received. A guide to the information to be gathered during a field investigation is presented and possible sources of pollution are discussed. Appendix A discusses the methods and problems of judging toxicity by bioassay and Appendix B lists selected bibliographies for those who must set up organizations and appraise the reports of bioassays at administrative levels. The bibliographies are grouped under two headings: 1—Bioassays and Toxicity and 2—Biological Indicators of Pollution.

480. Reimers, Norman, John A. Maciolek and Edwin P. Pister. 1955. LIMNOLOGICAL STUDY OF THE LAKES IN CONVICT CREEK BASIN, MONO COUNTY, CALIFORNIA. U.S. Fish & Wildlife Serv. Fishery Bull. 103, 66 pp.

The 10 glacial lakes of Convict Creek Basin in eastern California lie within a drainage area of 16 square miles, yet have enough variety in altitude, size and depth to be representative of many high-altitude trout lakes in the Sierra Nevada range. All are relatively poor in dissolved mineral substances, available heat, and aquatic vegetation. As a step toward finding a more precise measure of alpine lake productivity, this report presents analyses of physical, chemical, and biological data obtained in surveys conducted on these lakes between July 1950 and September 1951. The information has been treated separately

in the following categories: Physical influences, chemical influences, bottom fauna and plankton abundance, food habits of trout, and age composition and growth of trout populations. In each of these categories (except food habits) the 10 lakes have been ranked in high-to-low order of productive potential or production. The data have also been integrated to illustrate the degree of correspondence in ranking among physical, chemical, and biological divisions.

The lakes of the basin fall into groups and rough gradients for nearly all measurements, but the orders of lakes with respect to biological productivity are not in general agreement with the orders established on the basis of physical and chemical influences. Important causes of production differences were not definitely indicated, and no environmental factor or related group of factors can be named as a controlling influence on productivity as measured. The lack of biological agreement found among these lakes in terms of food availability and growth rates of trout suggests the need for a biological evaluation less biased than those now in use, possibly a measurement at the bacterial or "primary consumer" level. (A)

481. Riggs, Carl D. 1955. COLLECTING FISH BY COMBINED USE OF A SEINE AND AN ELECTRIC SHOCKER. Proc. Okla. Acad. Sci., Vol. 34—1953, pp. 30-32.

After repeated hauls with a common-sense minnow seine in a turbid pool failed to continue to produce results, and after the effectiveness of an electric shocker decreased markedly, the seine was again resorted to in combination with alternate brief periods of shocking with remarkable success. The original seine hauls captured 37 fish of 6 species, the shocker alone produced 31 fish of 7 species, and the combined method of shocker and seine produced 133 fish of 10 species. This method is believed to be particularly useful in rubble and boulder-strewn waters.

482. Watson, John E. 1955. THE MAINE SMALLMOUTH. Maine Dept. of Inland Fisheries and Game Fishery Res. Bull. No. 3, 31 pp.

This little booklet was printed to record for all interested persons the facts about bass management in Maine, and to give sportsmen the increased pleasure that comes with a better understanding of the fish. The booklet describes the smallmouth bass, its habitat and spawning requirements, growth, diseases and management. A summary of a 2-year study of smallmouth bass of Big Lake located in Washington County, is also presented.

483. Luethy, Don R. 1955. NOXIOUS VEGETATION CONTROL. Bull. No. 2, Fla. Game and Fresh Water Fish Comm. (Completion rpt. for Fla. Fed. Aid project F-2-D-2), May 6, 30 pp.

The Florida Game and Fresh Water Fish Commission began a water hyacinth (Eichornia crasippes) control program in 1952. This report summarizes the administrative and technological experience gained to date. The report should be of material value to any organization contemplating an attempt to control aquatic weeds by means of chemicals.

In aerial application it was found that 2,4-D ester (3.34 pounds acid-equivalent) applied at the rate of 0.5 gallon per acre was generally effective when used with an oil carrier. In air boat spraying, 2,4-D amine (4.0 pounds acid-Equivalent) in water as the carrier, was effective at the rate of 0.75 gallon per acre. Satisfactory results were obtained by treating water lettuce and lily pads with one gallon 2,4-D amine (4.0 pounds acid-equivalent) with 50 gallons of water and a strong detergent activator added for one acre of vegetation. Erratic results provide no basis for recommendation for control of cattail, maiden cane, water willow, button bush, coontail and pond weeds.

Specialized equipment materially improved operating efficiency and resulted in lowered costs. Per acre average costs for 3,909 acres of water sprayed were $2.99 for chemicals, $5.04 for operations, or $8.03 total. Practical suggestions about equipment, crew organization, publicity, false damage claims, and so forth, are given.

484. Iversen, Edwin S. 1955. SIZE FREQUENCIES AND GROWTH OF CENTRAL AND WESTERN PACIFIC BIGEYE TUNA. U. S. Fish and Wildlife Serv., Spec. Scientific Rpt--Fisheries No. 162, Sept., 40 pp.

Bigeye tuna (Parathunnus sibi) weight data from the Honolulu market for the period 1947-54, length data collected aboard Japanese tuna motherships in the equatorial western Pacific in 1951, and published length frequency distributions from the Japanese longline fishery in the northwest Pacific were compared and studied for evidence of growth and of local differences in the size composition of the population. In the data from both the equatorial western Pacific and Hawaiian waters the modes of the male size distributions were found to be about 14 cm. or 30 pounds larger than the corresponding female modes. Monthly weight frequencies of Hawaiian bigeye showed a consistent progression of modes, yielding a provisional growth curve that indicates that these fish may gain as much as 50 pounds in 1 year and may live about 6 or 7 years. Relatedness of the bigeye in Hawaiian waters and in the Japanese North Pacific fishery is suggested by the approximately similar growth rates and by the presence of a complementary 2-year cycle of dominant size groups in the catches of both areas. Data from equatorial waters showed no progression of the modes with time. (A)

485. Chipman, Walter A. 1956. PASSAGE OF FISSION PRODUCTS THROUGH THE SKIN OF TUNA. U. S. Fish and Wildlife Serv. Spec. Scientific Rpt--Fisheries No. 167, Feb., 6 pp.

Passage of the radioactive isotopes, strontium-89, cesium-137, and ruthenium-106, through the skin of the little tunny, Euthynnus alletteratus, was measured by using pieces of skin separating two sea waters, one of which contained the isotope. The diffusion of these isotopes through the tissues

under the skin of iced fish was observed after a number of days of contact with the skin surface.

Cesium entered the fish through the skin very readily and ruthenium scarcely at all. Except for cesium, diffusion through the fish tissues was slow.

After 4 days contact of the skin with the radioactive solutions, the activity from cessium of the deep muscle tissues was equal to that on the skin surface. On the other hand, after 8 days the activity of the deep tissues was only 4 percent of the skin-surface activity for strontium-89 and one percent for ruthenium-106. (A)

486. Nelson, Philip R. and Carl E. Abegglen. 1955. SURVIVAL AND SPAWNING OF GILL-NET-MARKED RED SALMON. U. S. Fish and Wildlife Serv. Res. Rpt. 40, 19 pp.

On Kodiak Island in Karluk Lagoon, 6,253 salmon were tagged in 1953 to determine the effect of gill-net marks on survival and spawning. Approximately half of these fish were gill-net marked and the remainder unmarked (control) fish.

Numbered tags of several color combinations were used so that observations could be made on each group of fish both enroute to and on the spawning grounds.

The results of the study show that the greatest mortality of net-marked fish occurred shortly after the fish were tagged and released. It is estimated that between 10 and 20 percent of the gill-net-marked fish escaping from gill nets die from webbing injuries. No difference was noted in the travel time of tagged control and tagged gill-net-marked fish from the lagoon to the spawning grounds. No significant difference was found between the spawning conditions of gill-net-marked fish and the control fish. There was a general tendency for gill-net marks to heal, and no relation was found between the seriousness of the gill-net marks and the survival of the fish. (A)

487. Watling, Harold and C. J. D. Brown. 1955. THE EMBRYOLOGICAL DEVELOPMENT OF THE AMERICAN GRAYLING (THYMALLUS SIGNIFER TRICOLOR) FROM FERTILIZATION TO HATCHING. Reprinted from Trans. of the Amer. Microscopical Soc., Vol. 74, No. 1, Jan., pp. 85-93.

Studies already completed on the American grayling in Montana include the feeding habits (Brown, 1938a, Brown and Buck, 1939), breeding habits (Brown, 1938b), age and growth (Brown, 1943), early life history and management (Nelson, 1954). The present work concerns the normal development from fertilization to hatching and brings to completion the program outlined for this species.

Development is followed in detail from a discription of unfertilized eggs, through successive stages of fertilization and pre-cleavage (0-7 hours after fertilization), cleavage (7-24 hours), blastula (24-60 hours), gastrula (60 hours-6 days), organogenesis (6-21 days), and fry.

488. Walburg, Charles H. 1955. RELATIVE ABUNDANCE OF MARYLAND SHAD, 1944-52. Fish and Wildlife Serv. Res. Rpt. 38, 17 pp.

Each year, the Maryland Department of Research and Education obtains catch and effort statistics from all commercial shad fishermen in Maryland waters as part of the Maryland Management Plan. These data for the years 1944 to 1952 were used in conjunction with a tagging experiment, to estimate fishing effort, fishing rate, catch, size of run, and spawning escapement for each of these years. It was found that effort had increased almost twofold, despite the operation of a plan designed to keep it constant.

The evaluation of the relation between factors which might cause changes in the size of the Maryland shad population is complicated because the effect of the Virginia shad fishery on the Maryland shad population is unknown. Without knowledge of this effect, the influence of other factors affecting the Maryland population is obscured.

Before Maryland can intelligently manage her shad fishery, Virginia must establish a system of collecting catch and effort statistics. With each State collecting these statistics, the shad fishery of Chesapeake Bay could be studied as a unit to determine the best management methods. (A)

489. Müller, Wolfgang. 1955. AUS DER POLNISCHEN BINNENFISCHEREI (About the Polish inland water fisheries). Deutsche Fischerei Zeitung, Vol. 2, pp. 144-150.

Production of pond fish is rapidly increasing in Poland. Carp is the chief cash crop, while trout, Atlantic salmon, and corregonids are grown in the hatcheries for stocking purposes. Research and extension service is on a high level. There are several research laboratories with 60-65 researchers and about 80 college-trained fishery biologists in the extension service. Close contact between the laboratories and fish production is maintained.

Since no organic food is released by the government for feeding of warm water fishes, only mineral and organic fertilizers are used for the increase of production. For a more efficient commercial utilization of fish ponds, fish culture is supplemented by culture of domestic ducks and pelt animals. In progressive fish farms much attention is given to cultivation of the pond soil. The area of contemporary Poland is 120,000 sq. mi. inhabited by 27,000,000 people. (S. F. S.)

490. Schäperclaus, W. 1955. BEDEUTUNG UND BECHANDLUNG DES TEICHBODENS IN DER KARPFENTEICHWIRTSCHAFT (The pond bottom soil, its role and maintenance in the culture of carp). Deutsche Fischerei Zeitung, Vol. 2, pp. 211-217, 243-246, and 300-306.

This is a review paper concerning the cultivation and treatment of pond soil and effects on the release of mineral nutrients, their solubility and storage. The first part discusses the role of calcium in pond soil, reserves of $CO_2$, source of Ca for plants, and neutralization by the ionic exchange of other metals which may accumulate in toxic quantities.

The second part discusses the role of phosphorus. Phosphate fertilizer, when added to water, is immediately assimilated by plants and most of it settles on the bottom in the form of dead organic matter. This gradually decomposes, releasing continuously small amounts of phosphorus which again is immediately assimilated. The availability of phosphorus determines the quantity of water bloom and therefore the productivity of the pond water. Addition of nitrogen fertilizer has little effect because most of it is lost by the process of bacterial denitrification. The best source of nitrogen in pond water is the nitrogen fixing bacteria. These fix the atmospheric nitrogen effectively in the presence of available phosphorus. Since the organic deposits on pond bottoms create excellent conditions for the survival of fish pathogens and parasites, ponds should be disinfected with CaO immediately after draining.

The third part discusses the benefits and dangers of mechanical cultivation and the effects of green manuring with legumes or cereals on the increase of organic matter, soil texture, release of minerals, and better aeration of the soil. A too rapid decomposition of green manure may dangerously deplete the dissolved oxygen. Proper handling and cultivation of pond soil has a considerable effect on fish production, decrease of undesirable vegetation and control of fish parasites and pathogens. (S. F. S.)

491. Steffens, W. 1955. TEICHPFLEGE IN WINTER (The care of fish ponds in winter). Deutsche Fischerei Zeitung, Feb., pp. 42-44.

The type of care which fish ponds should receive during winter depends on the nature and composition of the soil. If bottoms are covered with a thick layer of organic mud they should be plowed as soon as dry enough. If the layer of organic deposits is thin, plowing is detrimental because the most fertile layer of soil would be replaced by the poor. Drying and freezing is important for the control of parasites. Ponds or pond areas which can not be plowed or harrowed or even dried because of poor drainage should be disinfected with quick lime (CaO) which should be evenly distributed on the wet surface of the pond soil at a rate of 500-600 pounds per acre. (S. F. S.)

492. Wunder, W. 1955. DIE BESETZUNG DER FLÜSSE UND SEEN MIT KARPFEN. - EIN BEITRAG ZUR BAUCHWASSERSUCHT (Stocking of rivers and lakes with carp. - A contribution to the infectious dropsy). Allg. Fischereizeitung, Vol. 80, No. 1, pp. 13-14.

The assumption that carp from a population which was infected with dropsy caused by Pseudomonas punctata may recover when released into large bodies of water as rivers or lakes was tested. Such carp were released into the Danube River in Yugoslavia. Carp have not recovered and fish with typical symptoms of the disease were recovered from the river. It is concluded that there is no evidence of diseased fish released into large bodies of water recovering. It is very likely, therefore, that infected fish used for stocking of natural waters may carry the disease from one province or country to another. (S. F. S.)

493. Mortimer, C. H. and C. F. Hickling. 1954. FERTILIZERS IN FISH PONDS. A Review and Bibliography. Colonial Office. Fishery Publ. No. 5. London: Her Majesty's Stationery Office. pp. 4, 155.

This is a comprehensive review publication on the fertilization of fish ponds. It is divided into two parts. The first part presents a narrative review with numerical referencing to abstracts contained in the second part. Subjects covered are: 1. General works. 2. Construction and care of ponds. 3. Pond-muds, their chemistry, treatment and effect of dry periods. 4. Lime, chalk and limestone fertilizers, pH, carbon dioxide supply and related matters. 5. Potassium fertilizers, sulphur. 6. Fertilizers containing magnesium. 7. Phosphate fertilizers. 8. Nitrogenous fertilizers. 9. Organic manures. 10. Utilization of sewage in fish ponds. 11. Fertilization of peaty or acid ponds. 12. The effect of manures on fish ponds. 13. The direct effect of fertilziers on fish, and the causes of de-oxygenation in the water. 14. Manuring of trout ponds. 15. Conclusion.

The second part consists of abstracts of papers arranged alphabetically by author. Three hundred and fifty-one abstracts, critically reviewed and referred to in the first 15 sections, are presented here. (S. F. S.)

494. Carlander, Kenneth D. and George Sprugel, Jr. 1955. FISHES OF LITTLE WALL LAKE, IOWA PRIOR TO DREDGING. Reprinted from Proc. of the Iowa Acad. of Sci., Vol. 62, Dec. 15, pp. 555-566.

As little Wall Lake, Hamilton County, began to fill up after being completely dry in 1940 and 1941, a fish population developed. Apparently green sunfish and black bullheads got into the lake by 1944. Bluegills and largemouth bass were stocked in 1945. Bluegills reproduced successfully in 1947 and appeared to be replacing the green sunfish. All species except some bullheads, green sunfish, and fathead minnows were eliminated during the winter of 1948-49 after the water level dropped. The green sunfish were eliminated the next winter by more severe conditions. The bullheads and fathead minnows probably survive in muskrat burrows and other areas where oxygen may be available. Deepening of the lake by dredging in 1953 has changed conditions so that a new population of fish may survive.

The green sunfish showed rapid growth, reached a large size for this species, and provided good fishing in 1948. Bullheads showed rather slow growth, which may be the result of an over-abundance of this species despite winterkilling each year from 1949 through 1953. (A)

495. Gustafson, Paul V. and Robert R. Rucker. 1956. STUDIES ON AN ICHTHYOSPORIDIUM INFECTION IN FISH: TRANSMISSION AND HOST

SPECIFICITY. U. S. Fish and Wildlife Serv. Spec. Scientific Rpt.--Fisheries No. 166, Jan., 8 pp.

Transmission experiments demonstrated that Ichthyosporidium sp., occurring in rainbow trout, can be transmitted by three different methods: through intraperitoneal inoculation of fresh viscera homogenate into susceptible fish; through the feeding of fresh infected viscera; and through indirect contact between living carriers and susceptible fish. The host range has been demonstrated to include rainbow trout, chinook salmon, sockeye salmon, silver salmon, and a cottoid. Fish which were refractory were the goldfish, guppy, squawfish, and catfish. (A)

496. Anderson, G. C., G. W. Comita and Verna Engstrom-Heg. 1955. A NOTE ON THE PHYTOPLANKTON-ZOOPLANKTON RELATIONSHIPS IN TWO LAKES IN WASHINGTON. Ecology, Vol. 36, No. 4, Oct., pp. 757-759.

The seasonal changes in the phytoplankton and zooplankton populations were studied in Soap Lake and Lake Lenore, two highly saline lakes in central Washington, during the period March 1950 to March 1951. In Soap Lake, the phytoplankton population was large during the fall, winter, and early spring but was small at other times. The zooplankton, which consisted of Moina, Pedalia and Brachionus, were in abundance during the summer period of phytoplankton minimum and a clear reciprocal relationship was observed between population densities of Cladocera and phytoplankton. In Lake Lenore, there were two maxima in the phytoplankton population, one in April, dominated by Amphora, and one in September dominated by Chaetoceros. A large population of Diaptomus and Moina was maintained during the midsummer phytoplankton minimum. The decline of the summer zooplankton was followed by the second phytoplankton maximum which was in turn followed by a resurgence of Pedalia and Moina and a further small pulse of Diaptomus. A control of phytoplankton population size by the grazing activity of the zooplankton is given as the most probable interpretation of the seasonal changes observed. (A)

497. Gunning, Gerald E. and William M. Lewis. 1955. THE FISH POPULATION OF A SPRING-FED SWAMP IN THE MISSISSIPPI BOTTOMS OF SOUTHERN ILLINOIS. Ecology, Vol. 36, No. 4, Oct., pp. 552-558.

Aquatic fauna and flora were studied at Pine Hills Swamp in the Mississippi River Bottoms a short distance north of Wolf Lake. The area is a natural, undisturbed swamp which probably contains much of its native flora and fauna. Primary emphasis was placed on the fishes. Twenty-three species of fishes were taken during the survey. The pirate-perch, mudminnow, starhead topminnow, spring cave-fish, pigmy sunfish, and small sunfish were found to be the most abundant. Mud pickerel, round sunfish, bluegill, warmouth bass, largemouth bass, creek chubsucker, carp, yellow bullhead, mosquito fish, and swamp darter were taken in limited numbers. Single specimens of green sunfish, orangespotted sunfish, pumpkinseed, black crappie, golden shiner, brown bullhead, and bowfin were collected.

498. Personius, Robert G. and Samuel Eddy. 1955. FISHES OF THE LITTLE MISSOURI RIVER. Copeia, No. 1, Feb. 18, pp. 41-43.

Eighteen species of fish are listed for the Little Missouri River in Wyoming and North Dakota, based on sampling during June and July of 1950, and reports by others. Except for carp, these species are probably native. Four additional species, largemouth bass, black crappie, pumpkinseed, and northern creek chub, found in tributaries, were apparently introduced. The native fishes of the Little Missouri River are typical of the western tributaries of the Missouri River, but differ somewhat from those of the eastern glaciated tributaries in North Dakota. Only Pimephales promelas was common to both drainages.

499. Marr, John C. 1955. THE USE OF MORPHOMETRIC DATA IN SYSTEMATIC, RACIAL AND RELATIVE GROWTH STUDIES IN FISHES. Copeia, Issue No. 1, Feb. 18, pp. 23-30.

The relation of size of body part to size of body in fishes will generally conform to either rectilinear, power, or exponential equations. The latter two may be easily transformed to straight lines by the appropriate use of logarithms. For such straight-line regressions there are conventional methods of characterizing the lines, computing their variance, and comparing them.

Systematic studies and, to a lesser extent, racial and relative-growth studies often present data on body proportions in the form of ratios, averages of ratios, or regressions of ratios. These methods, as opposed to the regression analysis of original variates, are inefficient and may often lead to erroneous interpretation. A simple hypothetical example, as well as several examples from the literature, are used to demonstrate the point. (A)

500. Oppenheimer, Carl H. 1955. THE EFFECT OF MARINE BACTERIA ON THE DEVELOPMENT AND HATCHING OF PELAGIC FISH EGGS, AND THE CONTROL OF SUCH BACTERIA BY ANTIBIOTICS. Copeia, No. 1, Feb. 18, pp. 43-49.

A series of 13 antibiotics were tested alone and in combination for their effect on bacterial populations in sea water from the coast of southern California and from Oslofjord, Norway. Most of the aerobic, heterotrophic bacteria from sea water near La Jolla, California, were inhibited. While the antibiotics did appreciably decrease the numbers of bacteria in sea water from Oslofjord, more bacteria were resistant. Penicillin, streptomycin and chloromycetin were the most effective in reducing the bacteria populations; however, chloromycetin proved to be toxic to the eggs studied.

Pelagic eggs of Pacific sardine (Sardinops caerulea), Norwegian codfish (Gadus collarias) and Pacific turbot (Pleuronichthys sp., probably ritteri) utilized in this study were obtained by

collection from the sea in plankton nets or by the removal and fertilization of mature eggs. The early-stage eggs were incubated in running sea water and in circulating sea water containing antibiotics. A mixture of penicillin and streptomycin did not appreciably increase or decrease the rate of development, but did increase the percent of eggs hatching. This percent in the antibiotic solution was three times greater than that in running sea water. Microscopic examinations demonstrated that the eggs in running sea water had many bacteria on their surfaces, while those in antibiotic solutions had very few bacteria. Numerous bacteria were also demonstrated on the surfaces of later-stage eggs collected from the sea. During the long incubation time required by the cod eggs at 5° C., it was noted that an abundance of algae, bacteria and diatoms were present on the egg shells. At this time the eggs lost their buoyancy and fell to the bottom of the incubation chamber. (A)

501. Pfeiffer, Rev. Roman A. 1955. STUDIES ON THE LIFE HISTORY OF THE ROSYFACE SHINER. (NOTROPIS RUBELLUS). Copeia, No. 2, May 20, pp. 95-103.

Notropis rubellus was observed spawning over a period of six days from June 23 to June 28, 1941, in Five Mile Creek, Cattaraugus County, New York. Spawning was preceded by a behavior pattern in which schools of N. rubellus coursed up and down the length of two connected pools. The spawning site was located in shallow water over gravel at the side of a swiftly flowing riffle. Spawning was periodic and was accompanied by movements into and out of the breeding area. Newly hatched young, 5 millimeters in length, were secured on the eighth day after spawning was first observed. Egg counts made from preserved specimens ranged in number from 450 in one-year-old females, to 1,482 in three-year-old females. Scale readings indicated no fish over three years old. Their standard length ranged from 30 millimeters in immature specimens to 75 millimeters in three-year-old fish. Males grow faster the first year, but females attained the greater length at two and three years of age.

Food eaten consisted mainly of aquatic and terrestrial insects. Arachnida, vegetation, fish eggs, and fish remains were present in small quantities. Stomachs examined from breeding specimens rarely contained food. (A)

502. Bardach, John E. 1955. THE OPERCULAR BONE OF THE YELLOW PERCH, PERCA FLAVESCENS, AS A TOOL FOR AGE AND GROWTH STUDIES. Copeia, No. 2, May 20, pp. 107-109.

Examination of the opercular bone of yellow perch from Lake Mendota, Wisconsin, indicated this method to be reliable for determining age and growth. Satisfactory agreement was obtained between sizes calculated from opercular bones and measured averages. Opercular bones from 628 male and 548 female yellow perch were examined. These fish ranged in size and age from approximately 95 to 265 mm. and from 1 through 6, respectively. It was noted that opercular bones have been successfully used for age and growth determinations of Perca fluvialilis, a closely related European species.

503. Arnold, Edgar L., Jr. 1955. NOTES ON THE CAPTURE OF YOUNG SAILFISH AND SWORDFISH IN THE GULF OF MEXICO. Copeia, No. 2, May 20, pp. 150-151.

Standard length, date and time of capture, gear used, and locality are given for 15 larval and 1 juvenile sailfish and 32 larval swordfish. All were taken in the Gulf of Mexico from April 29, 1951 to June 19, 1953. The swordfish ranged in size from 6.1 to 79.5 millimeters; sailfish specimens ranged from 3.6 to 64.1 millimeters. These capture records strongly indicate that parts of the Gulf of Mexico serve as nursery grounds for these two species. In partial support of this, 17 out of 18 sailfish boated off Port Isabel, Texas, in August 1940, had ova in all stages of development and several taken later the same season extruded ova.

504. Bullis, Harvey R., Jr. 1955. OBSERVATION ON SCHOOLING JUVENILE TUNA, EUTHYNNUS ALLETTERATUS, IN THE GULF OF MEXICO. Copeia, No. 2, May 20, p. 153.

A total of 96 specimens of Euthynnus alletteratus ranging from 20 to 31 mm. fork length (average of 25 mm.) were captured from two schools on the night of July 19, 1954, from the Fish and Wildlife Service exploratory research vessel M/V Oregon in the offshore waters of the Gulf of Mexico. These schools were observed to swim back and forth under the ship's light often coming within a few inches of each other, but always retaining their separate identities without observed exchange of individuals. This is the only occasion when scombrids of this size range have been observed in schooling associations.

505. Mefford, H. P. 1955. FIRST RECORD OF THE MULLET MUGIL LIZA FROM FLORIDA. Copeia, No. 2, May 20, p. 149.

On December 6, 1952, in the course of routine examination of catches of black or striped mullet, Mugil cephalus, caught at Salerno, southeastern Florida, one specimen of the Caribbean and West Indies species, Mugil liza was found. This is the first recorded specimen from Florida waters.

506. Duwe, Arthur Edward. 1955. THE DEVELOPMENT OF THE GAS BLADDER IN THE GREEN SUNFISH, LEPOMIS CYANELLUS. Copeia, No. 2, May 20, pp. 92-95.

Gas bladders arise in one of three ways; as a diverticulum from the gut, as a solid mass of mesodermal cells which later is invaded by an endodermal evagination from the gut, and as a solid mass of cells originating in the region of the esophagus in which later appears a cavity communicating with the esophagus. It is known that either physostomous or physoclistis fishes may have gas bladders originating as a diverticulum from various places in the gut, the first origin listed. It is also known that in certain physostomous types the gas

bladder arises as a solid clump of cells, the second and third origins listed.

Embryos of the green sunfish, fixed for sectioning at 31 stages from 47 to 292 hours after incubation, showed a distinctive origination of a physoclistus type of gas bladder. The gas bladder of the green sunfish during its development recapitulates in part the physostomous type of gas bladder, which originates not as a diverticulum of the foregut, but as an independent solid mass of undifferentiated cells. This is the first demonstrated instance of a physoclistus type originating in this manner.

507. Slastenenko, E. P. 1955. A REVIEW OF THE BLACK SEA FISH FAUNA AND GENERAL MARINE LIFE CONDITIONS. Copeia, No. 3, Aug. 19, pp. 230-235.

This is a condensation of the author's comprehensive monograph "The Fishes of the Black Sea Basin" which consists of special and general parts on hydrology, hydrobiology, zoogeography, faunal origin, and geological history of the Black Sea and its fishes.

508. Weinreb, Eva Lurie and Nellie M. Bilstad. 1955. HISTOLOGY OF THE DIGESTIVE TRACT AND ADJACENT STRUCTURES OF THE RAINBOW TROUT, SALMO GAIRDNERII IRIDEUS. Copeia, No. 3, Aug. 19, pp. 194-204.

The histology of the digestive tract of the rainbow trout is similar to that of the king salmon. The structure of the tissue layers of the esophagus, stomach, pyloric valve, intestine and caeca, as well as the swim bladder and duct, is described. A brief description of the liver and pancreas is included. Special attention has been given the unique structures of the pyloric valve and the sphincter surrounding the swim bladder duct. Phagocytic activity in the digestive tract and related organs is described following intraperitoneal injections of Thorotrast. The granule cells have been studied by means of histochemical tests and their chemical structure determined on the basis of these tests and the effects of various fixatives. The presence of mucopolysaccharides and sites of alkaline phosphatase activity were determined in the entire digestive tract and swim bladder. (A)

509. Davis, R. E. 1955. HEAT TRANSFER IN THE GOLDFISH, CARASSIUS AURATUS. Copeia, No. 3, Aug. 19, pp. 207-209.

Thermal interchange between fish and water of rapidly changing temperature was studied. It was shown that living fish adjusted to changing temperatures considerably faster than dead fish. It was also apparent that the circulatory system and the gills play an important role in the transfer and distribution of heat.

Body temperature always corresponded closely to environmental temperature when the latter was held constant. Therefore, metabolical heat production was probably unimportant in these experiments. Body size of the animal involved has an important bearing on the rate of heat transfer. The smaller fish adjusted faster than the larger, and this relationship between fish of different sizes did not vary substantially when they were treated at different temperature intervals. Small fish may have a greater cardiac output per unit of body weight, or they may have a relatively greater gill surface permitting more rapid heat transfer than large fish. It may be that the rate of metabolism decreases with age and that there would be less vascularization of the external layers of tissues. Thus, there would be more insulation in larger and older fish than in smaller and younger fish. The need for further research on this phase of the problem is clearly indicated.

510. Briggs, John C. 1955. ILLUSTRATED WORKS ON FISHES. Copeia, No. 3, Aug. 19, pp. 243-245.

Claus Nisser's bibliographic work on fishes entitled "Shöne Fischbucher," published a short time ago, has as its primary purpose the listing of outstanding illustrated works on fishes. In order to bring this list to a reasonably satisfactory state of completion, 46 publications are proposed for addition.

511. Lennon, Robert E. 1955. ARTIFICIAL PROPAGATION OF THE SEA LAMPREY, PETROMYZON MARINUS. Copeia, No. 3, Aug. 19, pp. 235-236.

Sea lamprey were artificially propagated during 1950 at the Fish and Wildlife Service Laboratory, Hammond Bay, Michigan. Sperm was taken from 12 males and eggs were stripped from 5 females, however only 2 females proved to have ripe eggs. Evidence of successful fertilization of eggs from these two females was noted in about 4 hours. The first ammocoetes hatched in 10 days and most appeared by 12 days. Percent of hatching was high, but mortality of ammocoetes was high also. Prolarvae were unable to burrow in mud and sand until 3 weeks of age.

512. Reed, Roger J. 1955. OCCURRENCE OF THE WHITE LIVER GRUB, POSTHODIPLOSTOMUM MINIMUM, IN FISHES OF SLIPPERY ROCK CREEK, PENNSYLVANIA. Copeia, No. 3, Aug. 19, pp. 240-241.

Of the rosyface shiner, Notropis rubellus, taken by seine from nine streams in northwestern Pennsylvania during May-August of 1954, only those from Slippery Rock Creek and its tributaries were found to be infested with metacercaria of this trematode parasite. The presence of this parasite in N. rubellus is not new but its distribution in streams of this region is unique. Other fishes of Slippery Rock Creek infested, all of which have previously been reported as intermediate hosts, were the bluntnose minnow, central common shiner, rosyface shiner, central stoneroller, northern creek chub, western blacknose dace, and the rainbow darter. Both the little green heron and the great blue heron, final hosts of P. minimum, have been seen feeding in all nine streams sampled.

513. Schoffman, Robert J. 1955. AGE AND RATE

OF GROWTH OF THE YELLOW BULLHEAD IN REELFOOT LAKE, TENNESSEE. J. Tenn. Acad. Sci., Vol. 30, No. 1, Jan., pp. 4-7.

The average total lengths and weights for each age group presented in the following table are based on 507 yellow bullheads from Reelfoot Lake.

| Age Group | Number of Fish | Average Length (in.) | Average Weight (oz.) |
|---|---|---|---|
| I | 1 | 7.25 | 2.00 |
| II | 57 | 13.13 | 18.23 |
| III | 250 | 14.59 | 25.38 |
| IV | 130 | 15.84 | 31.80 |
| V | 69 | 16.87 | 38.33 |

If the length of age-group V (16.87 inches) is taken as 100 percent, it may be stated that 78 percent of the total growth in length is completed by specimens of age-group II, 86 percent by age-group III, and 93 percent by age-group IV. If the weight of age-group V (38.33 ounces) is taken as 100 percent, it may be stated that the total weights acquired for the second to the fourth age-groups inclusively are 47 percent, 66 percent, and 83 percent. No fish over 6 years old were taken.

514. Scott, Donald C. 1955. ACTIVITY PATTERNS OF PERCH, PERCA FLAVESCENS, IN RONDEAU BAY OF LAKE ERIE. Ecology, Vol. 36, No. 2, April, pp. 320-327.

In Rondeau Bay, perch, Perca flavescens (Mitchill), were the most abundant fish large enough to be caught by gill nets. In summer the two predominant groups of perch were two- and three-year-old migratory perch which were concentrated at the end of the bay nearer Lake Erie and migrated daily into the lake and two-year-old and three-year-old non-migratory perch remaining in the interior of the bay.

Activity patterns, as measured by gill-net catches, indicated that all perch were very inactive during the hours of darkness. Catches of migratory perch showed daily sunrise and sunset peaks. The low catch during midday was due to decreased local abundance. Non-migratory perch became active at sunrise, showed a peak of activity at about 1700 hours, and became inactive after sunset.

An approximate route of the daily migration of perch between Rondeau Bay and Lake Erie was detected chiefly by tabulating the direction in which the perch were headed when netted, by a chronological succession of peaks along the migration route, and by analyses of the stomach contents. Light appeared to play an important role in the timing of the beginning and ending of the day's activity. Time of the migration changed with the change in the time of sunrise and sunset during the season.

515. Marshall, Nelson. 1955. MEASUREMENTS OF PLANKTON FEEDERS IN RELATION TO GROSS PRODUCTION. Ecology, Vol. 36, No. 2, April, pp. 360-362.

Sets of the barnacle, Balanus improvisus, on tempered masonite slides were placed at three stations in Alligator Harbor, Florida. Periodically, slides from each station were removed and preserved for growth study. Greatest growth was exhibited in those placed toward the upper end of the Harbor. Statistical tests for significance of differences between station measurements indicated high probability that they were true population differences. Thus, the data, though limited, tend to indicate more rapid growth at the stations where higher chlorophyll measurements indicate a richer phytoplankton population. If circulation rates, within the limits common at these stations, affect growth rates, this influence tends to be obscured by the contrasting effects of the different phytoplankton levels. Oysters, placed in floating cages, were also utilized with similar results.

516. Rosine, Willard N. 1955. THE DISTRIBUTION OF INVERTEBRATES ON SUBMERGED AQUATIC PLANT SURFACES IN MUSKEE LAKE, COLORADO. Ecology, Vol. 36, No. 2, April, pp. 308-314.

Submerged rooted aquatic plants and their associated macroscopic invertebrates were collected in a montane pond in Bounder County, Colorado, at intervals between May 20 and October 26, 1950. The plants studied were Chara delicatula, Potamogeton gramineus, and Polygonum natans. The density of animals was expressed as the number of macroorganisms per 100 square centimeters of plant surface area. The distribution of the seven most abundant genera over the surfaces was determined, and detailed treatment was given the scud, Hyalella azteca, the most abundant invertebrate.

Considerable variation existed in the density of the animals on the three plants. A typical, mid-season distribution of Hyalella azteca was 2.0 amphipods per 100 square centimeters of Chara surface, 1.3 organisms per unit of Polygonum and about 0.3 on an equal area of Potamogeton. For the greater part of the season, Chara harbored the largest numbers of animals per unit of area, followed by Polygonum and Potamogeton, in that order. In various parts of the season Chara was found to support from 1.5 to 5 times as many animals as were found on Polygonum. A few factors which may be involved in causing the unequal distributions of the invertebrates are mentioned.

517. Moore, Walter G. 1955. THE LIFE HISTORY OF THE SPINY-TAILED FAIRY SHRIMP IN LOUISIANA. Ecology, Vol. 36, No. 2, April, pp. 176-184.

The distribution of Streptocephalus seali in Louisiana, based on intensive collecting activity over a period of several years, is outlined. The introduction of the species through transference of mature adults into a seasonal pool not previously known to harbor it is described. S. seali has been collected in Louisiana during every month of the year. Several successive generations during the year have been observed in pools subject to alternate flooding and drying; the maximum number of separate occurrences during any 12-month period being seven.

This species has been observed to occur at temperatures ranging from near-freezing in an ice-covered pool, to a maximum temperature of 42° C. All Louisiana habitats showed low hydrogen ion concentrations (pH 4.9-6.2), low total alkalinities (4.0-15.0 ppm), and wide extremes of color (maximum: 360) and turbidity (maximum: 3000 ppm). A beach pool on the Mississippi Gulf coast had a total alkalinity of 134.5 ppm, and a chloride content of 315 ppm.

Hatching of the eggs commenced within 30 hours following flooding of the habitat. Growth was characterized by an initial period of very rapid increase in length, an intermediate period of marked growth retardation, and a final phase of rapid growth. Egg production on a limited scale commenced during the middle period of retarded growth. In the shorter-lived, more rapidly growing summer broods growth continued uninterruptedly and at an increasing rate throughout the subsequent life span. In winter populations cessation of egg production in the early stages of the third growth phase was apparent, with an active resumption of egg production later in the life cycle. The maximum growth rate (2.0 mm. per day) and the shortest complete life cycle (16 days from flooding of the pool until drying) was observed in a forest pool habitat during June 1951. The ratio of males to females in natural populations of S. seali was approximately 1:1, with no consistent change during the life cycle.

518. Britt, N. Wilson. 1955. NEW METHODS OF COLLECTING BOTTOM FAUNA FROM SHOALS OR RUBBLE BOTTOMS OF LAKES AND STREAMS. Ecology, Vol. 36, No. 3, July, pp. 524-525.

Collection of bottom fauna was facilitated by immersing stones and other bottom material in a dilute solution of alcohol and HCl. This solution, prepared by adding to a 2 to 5 percent alcohol solution sufficient HCl to obtain a concentration of 0.03 to 0.06 percent, reversed the normal phototactic response of mayfly nymphs and certain other organisms. In deep water, where stones were not easily collected, small concrete slabs with roughened lower surface were placed on the bottom for 1 to 4 weeks. These soon became populated by small organisms. It was a simple matter to place these in various localities, raise them periodically, and immerse them in this solution to remove the organisms.

519. Bailey, Reeve M. 1955. DIFFERENTIAL MORTALITY FROM HIGH TEMPERATURE IN A MIXED POPULATION OF FISHES IN SOUTHERN MICHIGAN. Ecology, Vol. 36, No. 3, July, pp. 526-528.

A water temperature of 38° C. resulted in a high mortality of fishes confined in a shallow pond on the east side of Bass Lake, Livingston County. Symptomatic of distress was a marked lassitude, loss of orientation, and reduction of swimming ability. At a subsequent temperature of 35° C. survivors had normal powers of locomotion and activity. Of those species which did not suffer total mortality, only immature fish survived. There was a differential mortality for species, greatest loss occuring in the umbrid, catostomid, cyprinid, ictalurid, and percid groups; whereas, the cyprinodontid, poeciliid, and centrarchid groups (except Ambloplites rupestris) survived.

520. Benson, Norman G. 1955. OBSERVATIONS ON ANCHOR ICE IN A MICHIGAN TROUT STREAM. Ecology, Vol. 36, No. 3, July, pp. 529-530.

Observations were made on the Pigeon River, Otsego County, Michigan, during the winter of 1951-52 to determine the influences of anchor ice on stream ecology. Anchor ice formed during clear nights when the air temperature fell below minus 15.6° C. It formed most commonly in shallow turbulent water and usually floated away within 10 hours after its formation.

Samples of anchor ice on the stream bottom contained an average of 10 organisms per square foot plus sand, gravel, and organic debris. Floating anchor ice contained similar materials and fauna. All organisms collected were alive except for one dead trout fry in the egg-sac stage. Anchor ice formed temporary retaining dams on the stream bottom but the resultant flooding was not observed to significantly scar the stream bottom. The ice served as a method for downstream dispersal of bottom organisms; however, the small number so transported was not great enough to deplete the bottom fauna population.

521. Shkorbatov, G. L. 1954. SOME ECOLOGICO-PHYSIOLOGICAL CHARACTERISTICS OF WHITEFISHES ACCLIMATIZED IN WATERS OF EASTERN UKRAINE. Zoologicheskii Zhurnal Vol. 33, No. 6, pp. 1325-1335. (English translation by W. E. Ricker)

Whitefish reared under conditions new to them exhibit a considerably greater resistance to changes in oxygen and temperature than do whitefish living in northern waters where temperatures of 16-17° C. and oxygen contents of 10-11 mg./l. are considered limiting.

In the processes of acclimatization the ecologico-physiological characteristics of whitefishes and their other peculiarities must gradually change under the influence of the new conditions of existence. We must suppose that this process can be speeded up and guided along the required path by using the method of directed adaptation (napravlennoe vospitanie). The likelihood of success with this method is attested by the great physiological plasticity of whitefishes, which is most clearly revealed in the differences in respiratory intensity which were observed in young reared under different conditions.

Directed adaptation of fish is a new question, to be sure, but there are already some works which indicate ways in which it may be approached. Especially interesting in this connection are the studies of M. F. Vernidub (1949, 1950, 1951, etc.), which show that the action of unfavorable temperature and other factors on the eggs and larvae of various fishes during periods of increased metabolism and growth (resistant periods) can stimulate further development and increase the resistance of the organism to further action of the unfavorable

conditions. The work of P. A. Driagin (1952) also indicates a means of changing heat- and cold-resistance among fishes by the action of unusual temperatures. It is necessary that a broad study to work out methods of direct adaptation of fishes be inaugurated, beginning with the first stages of embryonic development and ending with the adult fish which is forming its sexual products. By actively furthering the process of producing of new adaptations (either ecologico-physiological or morphological) useful in the formation of new ecological forms (ecotypes) of commercial fishes, we not only make possible a significant acceleration of the process of acclimatization but we also to some extent extend the possiblities for acclimatization and consequently for an increase in productivity of waters.

522. Dawson, C. E. 1955. A CONTRIBUTION TO THE HYDROGRAPHY OF APALACHICOLA BAY, FLORIDA. Publs. of the Inst. of Mar. Sci., Vol. 4, No. 1, Sept., pp. 15-35.

Apalachicola Bay, a shallow coastal plain estuary, of the northwest coast of Florida, and the associated drainage system is discussed. The total area of the estuary is roughly 140 square miles. Apalachicola Bay is connected with the Gulf of Mexico through Indian Pass, West Pass, the eastern extremity of the bay and a recently dredged channel through St. George Island. The land drainage area which affects it directly is roughly 400 miles long and covers approximately 19,500 square miles.

The mean annual air temperature at Apalachicola is 68.7° F. with maxima during July and August and a January minimum. Total annual precipitation averages 56.29 inches and highest rainfall occurs during July, August and September.

Winds are found to be mainly easterly and northerly and those from the northerly quadrants are slightly predominant. Pronounced effects of wind on salinity distribution in Apalachicola are demonstrated. Northwesterly winds drive low salinity partially mixed river water to the eastward, whereas easterly winds generate westward drift. Except under conditions of high velocity, easterly or westerly winds, West Pass is the major outlet for Apalachicola Bay waters to the Gulf of Mexico.

Salinity characteristics are estuarine and range from nearly fresh water to 36 or more parts per thousand near the passes. Rapid short term salinity fluctuations are common throughout the area, and long term ranges of more than 35 parts per thousand are not infrequent. A close relationship was found between air and water temperatures, and a water temperature range of 25.5° C. was observed during the sampling period.

The probable effects of the dredged boat channel through St. George Island and the Jim Woodruff Dam now nearing completion, on the normal salinity distribution of Apalachicola Bay are discussed. It is expected that the channel will result in higher than normal mean salinities in the central bay water, and that salinity fluctuations in that area will be intensified. Except under conditions of excessive drought, the Jim Woodruff Dam will have little effect upon the normal salinity distribution in Apalachicola Bay. (A)

523. Geyer, Richard A. 1955. EFFECT OF THE GULF OF MEXICO AND THE MISSISSIPPI RIVER ON HYDROGRAPHY OF REDFISH BAY AND BLIND BAY. Publs. of the Inst. of Mar. Sci., Vol. 4, No. 1, Sept., pp. 157-168.

A hydrographic survey was conducted in Redfish and Blind Bays, on the southern edge of the Mississippi Delta, and in the adjoining areas in the Gulf of Mexico. Almost 1,100 observations were made at 49 locations during an 8-week period in the spring of 1953. Information was obtained on salinity, temperature, and current conditions.

These data are summarized and evaluated with emphasis on the effect of the Mississippi River and the Gulf of Mexico on the hydrography of Redfish and Blind Bays. A correlation exists between the stage of the Mississippi River and the salinity and temperature characteristics of these bays and their adjoining Gulf areas. Similarly, the diluting effect during high stages of the Mississippi River is evident over an area extending for several miles into the Gulf. It was noted that islands in Redfish Bay are wasting away. (A)

524. Koratha, Kunnenkeri J. 1955. STUDIES ON THE MONOGENETIC TREMATODES OF THE TEXAS COAST. Publs. of the Inst. of Mar. Sci., Vol. 4, No. 1, Sept., pp. 235-249.

The literature on the 30 species of Monogenea reported from the Gulf region before 1954 is reviewed and a note on euryhalinity in Monogenea is included. The host specificity in Monogenea and the importance of this knowledge in the systematic studies of fishes is emphasized. The work of Bychowsky (1933) is reviewed to point out the significance of the distribution of Monogenea on different carps in the study of systematic relationships of cyprinoid fishes. Literature on the relationships of the fish families Echeneidae and Rachycentridae is also reviewed. Parasitological findings are recorded to show the probable relationship of these two families. A survey is made of the Monogenea on marine fishes of Port Aransas, Texas. Three hundred and twenty-seven fishes belonging to 40 different species were examined. The number of positive and negative cases of infestation are recorded, along with data on host specificity. Forty percent of the species of hosts and 10 percent of fishes examined were found to be infested by Monogenea. Fourteen species belonging to seven families and 12 genera are recorded. (A)

525. Koratha, Kunnenkeri J. 1955. STUDIES ON THE MONOGENETIC TREMATODES OF THE TEXAS COAST (Part II.) Publs. of the Inst. of Mar. Sci., Vol. 4, No. 1, Sept., pp. 253-273.

A survey is made of the monogenetic trematodes of 327 fish, belonging to 40 different species, from Port Aransas. Fourteen species, consisting of 8 new species and 4 old species, belonging to 7 different families, are recorded and described. At the end of each description a short discussion is made of the distribution of that species and genus

in the Gulf region, in North America and in the world in general. (A)

526. Griffith, Ruth E. 1955. ANALYSIS OF PHYTOPLANKTON YIELDS IN RELATION TO CERTAIN PHYSICAL AND CHEMICAL FACTORS OF LAKE MICHIGAN. Ecology, Vol. 36, No. 4, Oct., pp. 543-552.

Analysis of frequent collections of near-shore waters of Lake Michigan showed that the greatest number of organisms, 4,507 units per ml., occurred in June and the lowest, 687 units per ml., in January. One major pulse occurred in the spring and five minor ones throughout the year. Myxophyta was the predominant phylum due primarily to exceedingly high numbers of Anacystis. Chrysophyta was next in abundance, followed by Chlorophyta. Pyrrophyta occurred in sporadic and relatively small numbers. The percent of Myxophyta was inversely proportional to the relative percent of Chrysophyta.

The temperature range could not be closely correlated with the abundance of any individual phylum, hence, its effects must be considered in relation to the many other environmental factors which influence phytoplankton growth.

In general, turbidity was higher preceeding a high phytoplankton pulse than during the pulse. The turbidity was higher when the percent of Chrysophyta per collection increased and conversely the turbidity was lower when the percent of Myxophyta and Chlorophyta per collection increased. There appeared to be a tendency, but no consistive relationship, for higher saturation values of oxygen when turbidities were low.

527. Elson, P.F. 1955. HAVE ATLANTIC SALMON BEEN OVERFISHED? Prog. Reps. of the Atlantic Coast Stas., No. 63, Nov., pp. 13-15.

Records of commercially caught Atlantic salmon have been kept for 85 years, 1870 through 1954. No relationship is apparent between the size of catches of parents and their offspring year classes. This was verified mathematically. It was concluded that the catches of salmon have not been limited by the number of adults escaping the nets and that if salmon stocks are to be increased, more promising means than restriction of fishing must be sought.

528. Odum, Howard T. and David K. Caldwell. 1955. FISH RESPIRATION IN THE NATURAL OXYGEN GRADIENT OF AN ANAEROBIC SPRING IN FLORIDA. Copeia, No. 2, May 20, pp. 104-106.

Beecher Springs, near Welaka in Putnam County, Florida, emerges from a limestone aquifer. During the 3-year period of observation, conditions were extremely constant, the oxygen content of the boil area being 0.3 ppm. and the temperature varying between 22° C. and 23° C. By placing Gambusia sp. and Mollienesia sp. in cages at various depths and locations and entirely out of water, it was determined that direct gulping of air is necessary for survival in this situation where an oxygenated surface film does not develop due to turbulence. This method of respiration was also observed in another spring in Sarasota County where several species of fish occur.

529. Nakamura, Hiroshi. 1955. REPORT OF AN INVESTIGATION OF THE SPEARFISHES OF FORMOSAN WATERS. U. S. Fish & Wildlife Serv., Spec. Sci. Rpt.--Fish. No. 153, July, 46 pp., illus.

Spearfishes of Formosan waters which consist of shortnosed spearfish, sailfish, striped marlin, black marlin, white marlin, and broadbill swordfish are compared with respect to external form, skeleton, and viscera. A key to family, genera, and species is presented and the types of boats, gear, and methods employed in spearfish fisheries are described.

The ecology of the spearfishes is discussed insofar as migrations and spawning habits are concerned; however, considerable gaps in the life history of these species still remain.

The spawning of spearfishes is not considered to take place in great groups in a very short period of time, but is believed to continue over a long period and over a broad area of the sea. In support of this, fish with ripe eggs and fish with unripe eggs have been found in a single area over a period as long as two months. Seasonal changes in oceanographic conditions no doubt account in a large part for seasonal abundance of spearfishes in Formosan waters. Further, it is clear that, excepting sailfish and shortnosed spearfish, spearfish do not migrate into Formosan waters to spawn. The presence in Formosan waters of great schools of scad and mackerel upon which spearfish feed seems a likely cause for their migration to these waters and for their presence during a 6-month period.

This report was first printed in Japanese in January 1938 as one of the reports of the Taiwan Government, General Fishery Experiment Station, 1937, No. 10.

530. Kutkuhn, Joseph H. 1955. FOOD AND FEEDING HABITS OF SOME FISHES IN A DREDGED IOWA LAKE. Proc. of the Iowa Acad. of Sci., Vol. 62, Dec. 15, pp. 576-588.

North Twin Lake, Calhoun County, was partially deepened by dredging in 1939. Stomach contents of yellow bass, yellow perch, walleye, black bullheads, black crappies, and orange-spotted sunfish were analyzed during the summers of 1953 and 1954. All sizes of each species were collected employing a systematic sampling scheme which permitted collection of these fish with respect to time of day. Stomach contents were analyzed immediately following capture using both numerical and volumetric methods.

In general, the food of the young-of-the-year of each species studied consisted mainly of planktonic crustaceans and minute immature insects. Yearlings fed primarily on the larger immature insect fauna, but gradually utilized increasing amounts of forage fish as they progressed toward the end of their second summer. Forage fish were the chief food of adults of all species excepting the orange-spotted sunfish which cannot utilize the proportionally larger forage fish. Young yellow bass were the principal

forage fish in 1953; young gizzard shad, in 1954.

531. Bailey, Reeve M. and William A. Gosline. 1955. VARIATION AND SYSTEMATIC SIGNIFICANCE OF VERTEBRAL COUNTS IN THE AMERICAN FISHES OF THE FAMILY PERCIDAE. Misc. Publs., Mus. of Zool., Univ. of Mich., No. 93, Sept. 28, 44 pp.

The present paper is an attempt to determine the value of vertebral number as a taxonomic character at specific, subgeneric, and generic levels in the Percidae. Vertebrae have been counted in some 5,413 specimens, representing 315 samples of 99 species of American percids.

It is concluded that there are certain average differences in vertebral number between genera and most subgenera and between many species within a subgenus. An analysis of these differences indicates vertebral number to be a powerful adjunct to phylogenetic interpretation, for in the American percids vertebral counts fit very well with a classification of these fishes (Bailey, ms) established on the basis of other criteria.

In the matter of differentiating genera, subgenera, and species, however, the vertebral number is of limited use in darters. This is because of the extensive overlapping in counts. A primary source of this overlap arises from the tremendous variation from sample to sample, even within subspecies. Since this sample variability in darters was one of our most unexpected and perplexing findings, considerable effort has been devoted to analyzing its possible causes.

As an attempt to find a more fundamental and consistent explanation for the variations that occur in samples of American percid species, we hypothesize that it is the amount of change (warming) in water temperature that occurs between spawning and the end of the sensitive period for vertebral formation that determines, at least in part, whether a sample will have a relatively high or low mean vertebral count. According to this hypothesis eggs laid in rapidly warming waters should have fewer vertebrae than genetically similar eggs spawned in more gradually warming waters. In lacustrine populations, thermal stratification may result in stimulation to breed at a given temperature with the resultant spawning occurring at a substantially different vertical and thermal level. Variations in spawning temperatures from lake to lake are reflected in average vertebral number, which is high when early development is in cool water, low if in warm water. Thus directional, altitudinal, and ecological gradients in vertebral numbers are all believed to result, at least in large part, from variations in temperature.

532. Shetter, David S. and Marvin J. Whalls. 1955. EFFECT OF IMPOUNDMENT ON WATER TEMPERATURES OF FULLER CREEK, MONTMORENCY COUNTY, MICHIGAN. J. of Wildlife Mgt., Vol. 19, No. 1, Jan., pp. 47-54.

An excellent opportunity to study the effect of an impoundment on trout stream temperatures has existed on the experimental waters of Hunt Creek Fisheries Experiment Station in southwestern Montmorency County, Michigan, since the inception of the station in 1939. This paper describes observations made in connection with the changes, resulting from re-establishment of an old beaver dam, on the subsequent stream teperatures below the dam.

Thermograph records for 3 years just prior to re-impoundment have been compared with the records for the 3 years, 1949, 1950, and 1951, following re-impoundment. Average daily air and water temperatures were calculated for critical periods for which records are available--June, July and August and January, February and March. The average of water temperatures for June of 1949-1951 exceeded that for June of 1946-1948 by 10.12° F.; for July the corresponding difference was 8.83° F.; and for August, 6.50° F. These differences were of a magnitude important to the stream as trout habitat. Obviously the differences were mostly a result of re-establishment of the impoundment; the differences can be related only to a small extent to differences in air temperatures. For June, the average of air temperatures in the period following replacement of the dam was 2.49° higher than before, while for July the figure for the later period was 0.63° higher, but for August the figure for that same period was 2.31° lower than for the earlier one. Averages of daily water temperatures for individual winter months in the post-impoundment period were 0.82 to 2.75° warmer than in the period preceding impoundment, and these differences were found to be statistically significant. A possible factor which might have influenced water temperatures is the variation in the flow of Fuller Creek during the period under consideration.

It is concluded that the re-establishment of the Fuller Creek dam, with the resultant spreading of the water over several times the normal stream channel area, raised midsummer water temperatures from 6.5° to 10.1° F. The effect of the dam on midwinter average daily water temperatures was obscured partially by significantly higher average air temperatures in January and February of the 3-year period, 1949-1951, combined with what is inferred to have been a significantly lower average discharge rate during this post-impoundment period.

The increase in midsummer water temperatures on Fuller Creek apparently did not change the quality of angling for brook trout in this stream, judging from intensive creel census records collected each year.

The catch per hour per angler for 1946-1948 was 0.166, and for 1949-1951 it was 0.149; the difference (0.017) is not statistically significant. The probable reason that the angling quality exhibited little change lies in the fact that the stream temperature increase after replacement of the dam, although of statistically significant proportions, was well within the limits of physiological tolerance by brook trout.

533. Schultz, F. H. 1955. INVESTIGATION OF THE SPAWNING OF NORTHERN PIKE IN PRINCE ALBERT NATIONAL PARK, SASKATCHEWAN, 1953.

Wildlife Mgt. Bull., Series 3, No. 4, Canada Dept. of Northern Affairs & Natl. Resources, 21 pp., multilith., illus.

From May 2 to June 7, 1953, the spawning run of great northern pike in Mud Creek, Prince Albert National Park, was investigated. Beaver had been removed from this stream in 1947, 1948, 1951, and 1953, and beaver dams were dynamited to give the great northern pike free passage in the stream at the commencement of the investigation.

The creek was found to be an important spawning area for the great northern pike of Lake Waskesiu. A trap, operated from May 4 to 15, captured 3,031 pike, 2,344 walleye pike, and 7,891 common and longnose suckers. The spawning run was estimated to consist of 6,000 great northern pike, 5,000 walleye pike, and 15,000 suckers. The run probably began about April 24, was at its peak on May 6, and was almost completed when trapping ended on May 15. A fluctuation of the run during cold weather following a snow storm suggested an activity gradient related to water temperature.

Length measurements were obtained for 368 mature great northern pike. The length distribution showed a normal curve with the peak at 22 inches and 65 percent between 20 and 24 inches. Creel census data indicated that anglers in Lake Waskesiu caught great northern pike in comparable length ranges.

Examination of 75 specimens indicated that great northern pike in Lake Waskesiu do not mature before reaching a length of 17 inches and an age of 4 years, and that most of them mature at about 20 inches and at 5 years of age. Increase in length is rapid during the first 4 years of life and regular at 2 to 2 1/2 inches a year thereafter up to 12 years of age. Weight growth accelerates with age, averaging about 2 pounds at 4 years of age, 6 pounds at 8 years of age, and 12 pounds at 12 years of age. Comparison with 1932 data showed that the only apparent change was a slight increase in average lengths, originating in the first year. This is attributed to the retention of the pike in the upper reaches of the creek by beaver dams, during their first winter. In a sample of 75 mature fish, 26 were females. No males examined were longer than 28 inches or more than 7 years of age. All stomachs of mature pike were empty. Immature pike moving downstream appeared to have been feeding exclusively on amphipods.

534. Rochford, H. Jitts, and A. Proctor. 1955. THE CHAINOMATIC PYCNOMETER: AN INSTRUMENT FOR THE RAPID DETERMINATION OF THE SALINITY OF SEA-WATER. Australian J. of Mar. and Freshwater Res., Vol. 6, No. 1, Feb., pp. 66-81.

This paper describes the Pettersson chainomatic pycnometer, as modified for use as a self-contained field unit, including its operation, calibration, and accuracy. It has been found to be a sturdy and reliable instrument capable of determining chlorinities with an accuracy of $\pm$ 0.05 $Cl^{o}/_{oo}$ units over a range of $Cl^{o}/_{oo}$ from 0.0 to 20.0. It is suitable for use as a field instrument and can be operated efficiently by semi-skilled personnel. In its present form its chief use would be for rapid on-the-spot chlorinity determinations in estuarine studies, though it can be useful in coastal studies where an accuracy of $\pm$0.05 is sufficient. If used with reasonable care, it requires very little servicing, though its calibration must be checked periodically. Suggestions have been made for increasing the accuracy of the instrument, and the authors feel confident that with certain improvements an accuracy of $\pm$0.01 $Cl^{o}/_{oo}$ units could be quite easily achieved, certainly in restricted chlorinity ranges.

An empirical equation has been derived for the determination of relative densities of samples from dial readings and temperatures with an accuracy of approximately $\pm$0.0001. The equation is useful for rough density determinations. However, if greater accuracy is required, it is necessary to calibrate the pycnometer in density units instead of chlorinity. Inquiries regarding supply of this instrument should be directed to G. & M. Manufacturing Company, New York, New York. (A)

535. Williams, George C. and Doris C. Williams. 1955. OBSERVATIONS ON THE FEEDING HABITS OF THE OPALEYE, GIRELLA NIGRICANS. Calif. Fish and Game, Vol. 41, No. 3, July, pp. 203-208.

The opaleye, Girella nigricana, though not highly regarded as a food or game fish is taken in large numbers by anglers and especially by spear fishermen. Examination of the stomach contents of 247 fish revealed a considerable and significant difference in diet between fish under 33 mm. and larger fish. No quantitative data for fish over 173 mm. were obtained. The newly recruited, 23 to 32 mm. young had a mixed plant-animal diet. About 55 percent of the individuals in this size group had more plant than animal matter in their stomachs while 85 percent of the larger fish had a preponderance of plant material. A single experiment showed that this finding could not be explained on the basis of a longer retention of plant than animal material.

536. Saunders, Dorothy Chapman. 1955. THE OCCURRENCE OF HAEMOGREGARINA BIGEMINA LAVERAN AND MESNIL AND H. ACHIRI N. SP. IN MARINE FISH FROM FLORIDA. The J. of Parasit., Vol. 41, No. 2, April, pp. 171-176.

Heart blood samples of 23 marine fish species collected in the Atlantic Ocean off St. Augustine, Florida, were studied for the presence or absence of parasites. All proved negative except Menticirrhus littoralis, the Gulf kingfish or whiting, and Achirus fasciatus, the hog choker. In 2 of 46 specimens of M. littoralis a haemogregarine was found. The observed stages of its life history, and measurements of the size ranges of these stages, correspond to those already described for Haemogregarina bigemina, to which species it is therefore considered to belong. This is the first such report of its occurrence in the United States.

In 3 of 35 specimens of Achirus fasciatus a haemogregarine was found with a schizont which was narrower than any other known haemogregarine species and outside the range of measurements previously given for them. It is therefore given the name of Haemogregarina achiri, n. sp. from the host fish in which it was found. (A)

537. Hargis, William J., Jr. 1955. MONOGENETIC TREMATODES OF GULF OF MEXICO FISHES. PART II. THE SUPERFAMILY GYRODACTYLOIDEA (CONTINUED). The J. of Parasit., Vol. 41, No. 2, April, pp. 185-191.

This paper is the second of a series on monogenetic trematodes of Gulf of Mexico fishes. It treats several species belonging to the subfamily Tetraonchinae and is a continuation of the data concerning members of the superfamily Gyrodactyloidea obtained during a recently concluded study of these ectoparasites. (A)

538. Sogandares-Bernal, Franklin. 1955. SOME HELMINTH PARASITES OF FRESH AND BRACKISH WATER FISHES FROM LOUISIANA AND PANAMA. The J. of Parasit., Vol. 41, No. 6, Dec., pp. 587-594.

Nine species of trematodes, three cestodes and two nematodes are reported from fishes in Louisiana. Two species of trematodes are reported from fishes in Gatun Lake, Panama. Most of the fish were taken from Lake Pontchartrain and at Edgard. Marine and fresh water fish occur together in the brackish waters of Lake Pontchartrain. Fresh water fishes were found to harbor fresh water parasites and marine fishes both fresh water and marine parasites.

539. Rigdon, R. H. and John W. Hendricks. 1955. MYXOSPORIDIA IN FISH IN WATERS EMPTYING INTO GULF OF MEXICO. The J. of Parasit., Vol. 41, No. 5, Oct., pp. 511-518.

Three species, variegated minnow (Cyprinidon variegatus), black chub (Fundulus similis), and mullet (Mugil cephalus), caught in a lagoon and in a slough, the water of which is continuous with that of the Gulf of Mexico, were infested with Myxosporidia. The genus could not be determined satisfactorily since all the material was fixed in formaldehyde. Apparently this is the first report of Myxosporidia in the waters of the Gulf of Mexico.

540. Weatherley, A. and A. G. Nicholls. 1955. THE EFFECTS OF ARTIFICIAL ENRICHMENT OF A LAKE. Australian J. of Mar. and Freshwater Res., Vol. 6, No. 3, Oct., pp. 443-468.

A Tasmanian highland lake of low natural productivity was enriched by the addition of a mixture of chemicals consisting of 40 parts of ammonium sulphate, 60 parts superphosphate, 5 parts potassium chloride, and 15 parts ground limestone. The first treatment was applied to the bottom mud and stimulated the existing stunted aquatic vegetation to produce a prolific growth; a later application, broadcast over a portion of the lake, had the additional effect of increasing phytoplankton and zooplankton. Concurrent with the growth of plants there was a marked increase in the total number of epiphytic fauna. Fish living in the lake at the time of enrichment showed a marked increase in growth rate, and others stocked later showed a similar response. It is tentatively concluded that phosphorus was the element responsible for the stimulus to the growth of plants and plankton. An unproductive lake of this type can by suitable enrichment be rendered capable, therefore, of carrying a stock of fish.

541. Westley, Ronald E. 1954. A MULTIPLE DEPTH RUNNING PLANKTON SAMPLER. Fisheries Res. Papers, Wash. Dept. of Fisheries, Vol. 1, No. 2, March, pp. 46-51.

The sampler consists of three parallel pieces of 1/2-inch galvanized pipe extending into the water over the side of a boat, each bent forward at a 90-degree angle at one, three, and five-foot depths. Forward movement of the boat forces water through the pipes into a common surge tank. By regulating the speed of the boat to maintain a constant level of water in the surge tank, the quantity of water collected is a function of the size of the orifice and the sampling period. Water from the orifice falls through a plankton net. Construction and mounting details are presented.

542. Miller, Robert Rush. 1955. A SYSTEMATIC REVIEW OF THE MIDDLE AMERICAN FISHES OF THE GENUS PROFUNDULUS. Misc. Publs., Mus. of Zool., Univ. of Mich., No. 92, Sept. 28, 64 pp. Illus.

This study of the systematics of the cyprinodontid fish genus Profundulus is based upon a morphological examination of 9,280 specimens, an analysis of the habits, habitat and ecology of the species, and a consideration of the effect of recent hydrographic changes on interspecific competition and on the dispersal and origin of the species. Although belonging to a family, the Cyprinodontidae, that tolerates wide fluctuations in salinity, this genus is known only from fresh water. Whether it has been wholly confined to fresh water during the history of its dispersal is problematical.

Five species of Profundulus, all illustrated, are recognized and are assigned to two distinct species groups. The punctatus group (subgenus Profundulus) includes punctatus and guatemalensis, two very closely related, allopatric species. The labialis group (subgenus Tlaloc) includes labialis, candalarius, and hildebrandi, of which the second is a geographic segregate of labialis, whereas hildebrandi, isolated atop the highest mountain mass of Chiapas, is believed to represent a much earlier evolutionary stage. Profundulus is distributed over both slopes of Middle America from southern Mexico to Honduras.

The recognition of Profundulus as a genus distinct from Fundulus, its closest relative, is substantiated by an appraisal of the characteristics used to distinguish all species of both genera. Two new taxonomic characters for separating these genera—the

form of the premaxillary process and the structure of the median hypural bone—were discovered in the present study.

543. Wendler, Henry O. and Gene Deschamps. 1955. LOGGING DAMS ON COASTAL WASHINGTON STREAMS. Fisheries Res. Papers, Wash. Dept. of Fisheries, Vol. 1, No. 3, Feb., pp. 27-38.

Logging dams on coastal Washington streams have in almost all instances had harmful effects on salmon and trout populations. The extent of damage has depended on the length of time a dam has remained in a stream, whether or not it has constituted a complete block to migratory fish, the location of the dam, the size of fish runs affected, the inclusion of a fishway and its efficiency, the amount of injury to fish and eggs, and the degree of environmental changes caused by splashing. Early rehabilitation efforts have centered on the removal of dams no longer in operation, the construction of small salmon hatcheries for planting fry, and the inclusion of fishways. There is now a concerted effort to free all rivers of barriers to fish migration by removal or laddering. This is to be followed by stocking upstream areas to supplement natural reproduction. A list of dams is presented giving their location, approximate length of time in the stream, and amount of stream made inaccessible for most coastal, Grays Harbor, and Willapa Harbor streams.

544. Thumann, E. M. 1955. ENTENHALTUNG AUF KARPFENTEICHEN (Production of domestic ducks in fish ponds). Deutsche Fischerei-Zeitung, Vol. 2, pp. 246-250 and 268-271.

Utilization of fish ponds for the simultaneous production of domestic ducks and carp was more profitable than production of carp alone. Fish production was higher and bottom fauna increased in ponds on which ducks were raised. Competition for fish food was not important and predation by ducks can be minimized by ample feeding. About 80 ducks per acre of water can be maintained. (S. F. S.)

545. Whitney, Richard R. and Kenneth D. Carlander. 1956. INTERPRETATION OF BODY-SCALE REGRESSION FOR COMPUTING BODY LENGTH OF FISH. J. of Wildlife Mgt., Vol. 20, No. 1, Jan., pp. 21-27.

The regression of body length on scale measurement appears to be the proper regression to use in describing the relationship between body and scale for growth computations. The usual use of the regression to find "adjusted" or "normal" scale measurements from which the lengths at various annuli can be computed involves the estimation of scale measurements from lengths with the body-scale regression when the scale-body regression would be more efficient and accurate for such estimation. An alternative procedure, estimating the body lengths from scale measurements and then "correcting" for deviations of scale size from normal, appears to be more logical. Either procedure gives identical results if the body-scale regression is linear. The use of a curvilinear body-scale regression introduces difficulties in interpretation since it does not take advantage of the assumption that body growth is related to proportionate growth of the scale rather than to absolute size of the scale.

Scales from a yellow bass indicated that the variances of body lengths estimated from proportionate growth of scales were much less than those for lengths estimated from absolute scale size. The use of the regression method without the correction or "normalization" of scale size may be quite satisfactory where the body-scale relationship has been adequately described and where samples are fairly large. With a curvilinear regression, it may be the only sound procedure.

The practice of averaging scale measurements at various body lengths to compute the body-scale relationship is erroneous. If the data are to be grouped, the mean body lengths at various scale measurements should be used.

Computation of the body-scale regression, without logarithmic transformation, probably usually involves disregarding the assumption that the variances of the body lengths are the same for each scale length. (A)

546. Davison, Verne E. 1955. MANAGING FARM FISH PONDS FOR BASS AND BLUEGILLS. U. S. Dept. of Agric. Farmers' Bull. No. 2094, Nov., 18 pp.

Pond site selection, dam construction, erosion control, stocking, fertilization, weed control, and fishing are discussed. This bulletin supercedes Farmers' Bulletin 1983, "Farm Fishponds for Food and Good Land Use."

547. Horton, H. F. 1956. AN EVALUATION OF SOME PHYSICAL AND MECHANICAL FACTORS IMPORTANT IN REDUCING DELAYED MORTALITY OF HATCHERY-REARED RAINBOW TROUT. Prog. Fish-Cult., Vol. 18, No. 1, pp. 3-14, illus.

The term "delayed mortality" is used to connote those deaths occurring during a period of seven days after transport, in contrast to immediate hauling loss. Eighty-four experimental trips, testing four factors for possible control of delayed deaths, were undertaken in 1954. The temperature of transporting water was found to be directly related to delayed loss at the three load levels tested. Highest mortality came from loads in which the water was 55° F., intermediate losses accompanied 47° F. loads, while effective control was achieved at 40° F. Sodium amytal at one-half grain per gallon of water afforded no control of delayed mortalities. Variation of loading and unloading techniques did not significantly affect delayed deaths. Use of Venturi-aerated liberation tanks provided effective control of losses at the temperatures tested. The California-type Venturi unit proved superior to a side-delivery design in controlling post-liberation losses. The factors of diet, fish condition, water turbulence within liberation units, and density of fish per gallon of transporting water may be associated with delayed mortalities. (A)

548. Wood, E. M. and W. T. Yasutake. 1956. HISTOPATHOLOGY OF FISH. II. THE SALMON-POISONING FLUKE. Prog. Fish. Cult., Vol. 18, No. 1, pp. 22-25, illus.

The metacercariae of the trematode, Nanophyetus salmincola, encyst in the tissues of salmonids at the rate of thousands per fish. There is no leucocytic response, but the organisms are the potential cause of marked obstructive and mechanical damage and may open pathways for the entry of other pathogens. (A)

549. Rowley, William E., Jr. 1955. HYDROSTATIC PRESSURE TESTS ON RAINBOW TROUT. Calif. Fish and Game, Vol. 41, No. 3, July, pp. 243-244.

Hydrostatic pressure tests on rainbow trout were conducted to determine conditions that occur in penstock and turbine chambers of a hydroelectric system. Eight-inch trout were subjected to pressures from 50 to 2,000 pounds per square inch for 6 to 48 seconds. Pressure release was virtually instantaneous. No detrimental effects were noted during the following 2-week observation period.

550. Springer, Paul F. 1955. PLANT PESTICIDES AND WILDLIFE. The N. C. State College of Agric. and Engineering. A 16-page pamphlet reprinted from the 1955 Pesticide Handbook.

Common herbicides and fungicides and their toxicity and repellency to wildlife are discussed. Many of these materials are normally applied only in terrestrial situations, but their possible effects on aquatic life are reviewed to show possible hazards if allowed to enter streams and ponds. The herbicides discussed are: 2,4-D and related compounds, ammate, trichloracetic acid, sodium chlorate, sodium borate, sodium arsenite, sodium cyanate and potassium cyanate, copper sulfate, dinitrophenol compounds, chlorinated benzenes, aromatic solvents, pentachlorophenol and sodium pentachlorophenate, isopropyl N-phenyl carbamate, CMU, Dalapon Delrad. Fungicides covered are: inorganic sulfur, organic sulfur compounds, mercury compounds, copper carbonate and quinone compounds. It is concluded that both the chlorinated benzenes and the aromatic solvents, as well as the dinitrophenol compounds should be used with extreme caution if fish are a consideration in the treated area.

551. Hey, D. 1955. THE INLAND FISHERIES OF THE CAPE PROVINCE. Rpt. from the Proc. of the Int. Assoc. of Theoretical and Applied Limnol., Vol. 12, pp. 342-345.

The Inland Fisheries Division of the Department of Nature Conservation was reconstituted with headquarters at Jonkershock in 1943. The division now operates two main hatcheries, one at Jonkershock and the other at Pirie. The former covers an area of 30 acres and produces 3 species of trout, 3 species of bass, goldfish varieties, 25 species of tropical fish, and frogs. The Pirie hatchery covers an area of 10 acres and is largely concerned with culture of trout. Fresh water fish are distributed free of charge to all public waters in the Province; on an assisted basis to local authorities and angling associations, but are sold for stocking private waters.

In addition to culture of fish, the Department is actively concerned in a number of projects to promote the economic development of inland fisheries, including the culture of fish for food in farm ponds, culture of fish at sewage outfall works, and the commercial exploitation of certain river fisheries. Also, adequate facilities have been provided for fisheries research at Department headquarters in the form of four sizeable and well equipped laboratories for chemical, biological, pathological, and histological work. Considerable importance is attached to educational and publicity aspects of the program.

552. Reid, George K., Jr. 1955. A SUMMER STUDY OF THE BIOLOGY AND ECOLOGY OF EAST BAY, TEXAS, PART I. The Texas J. of Sci., Vol. 7, No. 3, Sept., pp. 316-343.

East Bay, a shallow body of water lying within Galveston County, joins Galveston Bay to the southwest, but is rather effectively separated from it by a series of sand and shell reefs. This study is designed to evaluate the effects of cutting a fish pass through Bolivar Peninsula to the Gulf. The present study, made prior to the cutting of the pass, will be used as a basis for comparison with a similar investigation following joining of Bay and Gulf. East Bay's bottom composition and configuration, tides and currents, salinity, pH, temperatures, turbidity, plankton, and some aspects of the fish populations and other faunal components are discussed.

553. Reid, George K., Jr. 1955. A SUMMER STUDY OF THE BIOLOGY AND ECOLOGY OF EAST BAY, TEXAS, PART II. The Texas J. of Sci., Vol. 7, No. 4, Dec., pp. 430-453.

The second part of this paper, consisting of a discussion of the fish fauna of East Bay and the Gulf Beach, reports 16 groups of larger invertebrate animals. Shrimps, ctenophores, and medusoid jellyfish were abundant during the investigation.

Fifty species of cartilaginous and bony fishes were recorded for East Bay. These species represent 46 genera and 30 families. Anchovies (Anchoa mitchilli diaphana and A. hepsetus), spot (Leiostomus xanthurus), croaker (Micropogon undulatus), and menhaden (Brevoortia patronus) were the most conspicuous fishes during the period of investigation. Within the bay, there were indications of distributional patterns wherein some species were found more abundantly in certain areas. The great numbers of young croaker, spot, and menhaden pointed to the role of the bay as a nursery ground. Predation on the young fishes was severe, especially on menhaden. Food was apparently abundant; zooplankters, shrimp, and a pelecypod, Macoma mitchelli, were taken by many species. Only a few species showed evidence of active breeding during the summer.

Collections in the Gulf, representing 25 species included 5 species not taken in the bay. Of the species common to both areas, size differences and variations in relative abundance were observed.

554. Dymond, J. R. 1955. THE INTRODUCTION OF FOREIGN FISHES IN CANADA. Proc. Int. Assoc. Theoretical & Applied Limnol., Vol. 12, pp. 543-553.

Only four species of fishes not native to North America are known to have been introduced and to have survived in Canada and only two of these, the carp and brown trout, are of significance. The origin, present range and success of the introduction of the four exotic species, carp, goldfish, tench, and brown trout, as well as several species native to Canada, but transferred to regions in which they did not naturally occur, are discussed. Species included in the latter category are rainbow trout, Atlantic salmon, Pacific salmon, eastern brook trout, American smelt, and smallmouth bass.

555. Skud, Bernard Einar. 1955. LENGTH-WEIGHT RELATIONSHIP IN MIGRATING FRY OF PINK SALMON (ONCORHYNCHUS GORBUSCHA) IN SASHIN CREEK, LITTLE PORT WALTER, ALASKA. Copeia, No. 3, Aug. 19, pp. 204-207.

The spawning migration of pink salmon, Oncorhynchus gorbuscha, at Sashin Creek, Little Port Walter, Alaska, occurs during the months of August and September. The seaward migration of fry takes place during March, April, and May. Length measurements show that females in the early part of the run are larger than those in the later portion of the run. If early and late migrating fry are progeny of early and late adults, respectively, a similar trend of size might be expected.

Data from Sashin Creek was given intensive statistical treatment. A regression diagram exemplifies the phenomenon that, for a given length class, the weight of early migrants is greater than the weight of late migrants. Thus, fry exhibited the same trend in size as adults during their spawning migration. Early egg deposition, coupled with favorable thermal conditions, is believed to be the factor predominantly affecting size differences between early and late fry migrants.

556. Orton, Grace L. 1955. EARLY DEVELOPMENTAL STAGES OF THE CALIFORNIA BARRACUDA, SPHYRAENA ARGENTEA GIRARD. Calif. Fish & Game, Vol. 41, No. 2, April, pp. 167-176.

This paper describes the development of Sphyraena argentea through early post larval stages on the basis of studies on both living and formalin-preserved specimens. Identification was established by the diagnostic somite count and by rearing larvae for several days after hatching. Comparisons of the developmental characters of the Pacific barracuda are made with characters of advanced embryos and larvae of carangid fishes and with early stages of S. sphyraena of the Mediterranean, the only information on early stages of another species of Sphyraena revealed by a preliminary search of the literature.

557. Hale, John G. and Lloyd L. Smith, Jr. 1955. RESULTS OF PLANTING CATCHABLE-SIZE BROWN TROUT, SALMO TRUTTA FARIO L., IN A STREAM WITH POOR NATURAL REPRODUCTION. Paper No. 3165, Sci. J. Series, Minn. Agric. Exp. Sta., St. Paul 1, Minn., Jan., pp. 14-19.

During the 1949 angling season, 358 fishermen caught 481 trout from Watson Creek located in southeastern Minnesota. Of this group, 478 fish were from the 1,625 marked brown trout planted in September 1948, two were unmarked brown trout and one was an unmarked brook trout. Anglers spent 1,047 hours on the stream and caught trout at the rate of 0.6 per hour. At the close of the first 2 days of fishing, 63.5 percent of the total catch of the year had been made; by the end of the fourth week, 80 percent had been taken. Although the season covered 20 weeks, 71 percent of the total angling effort had been expended by the close of the fifth week.

On the basis of an estimate for April derived by shocking, 696 fish, or 42.8 percent of the 1,625 trout planted the previous September, had survived to the beginning of the following fishing season. By June 25, after 433 trout had been taken by anglers, estimates showed that only 7.6 percent of the original planting remained. On September 21, after the close of the season, it was estimated that only 3.6 percent of the 1948 fall planting had survived. Of the original plant, 57.2 percent had apparently succumbed to natural causes before the fishing season, an additional 9.8 percent were lost from natural mortality during the season, and 29.4 percent were caught by anglers. Of the fish available at the beginning of the season, 68.7 percent were taken by anglers.

Over-winter growth of trout was 0.9 inch and 0.08 pound. This growth could be actual increment or could represent a selective survival of larger fish. Fish failed to increase in length during the fishing season; this probably reflects selectivity of angling.

On the basis of a cost of $2.40 per pound of trout planted, each fish planted was worth $0.38. On the basis of 29.4 percent survival to the creel, each fish taken by the angler cost $1.26.

558. Dill, William A., Millard Coots and Philip A. Douglas. 1955. THE STATUS OF THE PUMPKINSEED, LEPOMIS GIBBOSUS (LINNE), IN CALIFORNIA. Calif. Fish & Game, Vol. 41, No. 2, April, pp. 157-159.

The first record of pumpkinseed in California is from an artesian-fed reservoir south of Mecca, Riverside County, in 1939. It was believed that they had disappeared from this pond by 1943. In 1942, seven specimens were taken from the Susan River, Lassen County, just below U. S. Highway 395 crossing. Just 11 years later, another specimen was taken from the Susan River very close to

this locality. A survey in 1954 disclosed a sizeable population in the lower Susan River near Honey Lake. In 1942, a collection was taken from Antelope Creek, a tributary of Lost River, Modoc County. A record of pumpkinseed planting in Irvine Lake (Santiago Reservoir), Orange County, was based on field identification alone. There is no further information on their presence in this lake or elsewhere in Southern California.

The newest locality record was obtained in 1951 from a small mining dredge pond along the Klamath River, Siskiyou County. Since that time, other specimens have been taken both in the Klamath River and in Copco Lake which is formed by the river. Both pumpkinseeds and green sunfish now appear to be quite common in mining dredge holes and quiet stretches of the upper Klamath River in California. It is obvious that the pumpkinseed occupies a minor place in California's fishery, but further distribution might enable it to gain a strong foothold throughout the State.

559. Kesteven, G. L., and G.E.R. Deacon. 1955. THE CONTRIBUTION OF OCEANOGRAPHIC RESEARCH TO FISHERIES SCIENCE. FAO Fish. Bull., Vol. 8, No. 2, April-June, pp. 67-76.

A general dissertation of the role of oceanography in providing a better understanding of the distribution, abundance and behavior of fish, and of fishery science in general.

560. Philip, Cornelius B. 1955. THERE'S ALWAYS SOMETHING NEW UNDER THE "PARASITOLOGICAL" SUN (THE UNIQUE STORY OF HELMINTH-BORNE SALMON POISONING DISEASE). J. of Parasit., Vol. 41, No. 2, April, pp. 125-148.

Although a review of progress on the problem of salmon poisoning disease of dogs is specifically not the intention of this paper, it provides considerable information along these lines. Recent investigations of the author and related work are reviewed. The fact that study of helminth-borne microbial diseases is still in a pioneer stage is emphasized.

561. Chimits, Pierre. 1955. TILAPIA AND ITS CULTURE. FAO Fish. Bull., Vol. 8, No. 1, Jan.-March, pp. 1-33.

A comprehensive documentation of literature on Tilapia consisting of a bibliography of 94 papers and accompanying brief abstracts is presented. The text of this paper is a summary of information drawn from these papers and covers the importance of Tilapia fisheries in native waters, acclimatization of Tilapia to new waters, biology of the three principle species raised in fish culture, and the present methods of raising Tilapia. Ten species of about 100 known to exist are compared in regard to area of origin, food, length and weight, incubation, and culture.

562. Lawrence, John M. 1956. PRELIMINARY RESULTS ON THE USE OF POTASSIUM PERMANGANATE TO COUNTERACT THE EFFECTS OF ROTENONE ON FISH. Prog. Fish-Cult., Vol. 18, No. 1, pp. 15-21.

Aquaria tests were conducted in the laboratory at selected temperatures from 44° to 81° F. to determine the concentration of potassium permanganate required to counteract the effects of 0.05 ppm. rotenone on bluegills, largemouth bass, goldfish, and fathead minnows. Results over the entire temperature range indicate that 2 ppm. potassium permanganate would counteract all effects of rotenone to the species of fish tested. Field trials indicated that 2 ppm. potassium permanganate applied as a water solution would successfully counteract the effects of 0.05 ppm. rotenone to fish. Potassium permanganate slightly in excess of 2 pounds potassium permanganate per 0.05 pound rotenone, applied below sample areas in small streams successfully counteracted all effects of rotenone downstream from the poison area. (A)

563. Cross, Frank B., Walter W. Dalquest and Leo Lewis. 1955. FIRST RECORDS FROM TEXAS OF HYBOPSIS GRACILIS AND NOTROPIS GIRARDI, WITH COMMENTS ON GEOGRAPHIC VARIATION OF THE LATTER. Texas J. of Sci., Vol. 7, No. 2, June, pp. 222-226.

Collections made in 1954 reveal that both the flathead chub and the Arkansas River shiner are common in the Canadian River in Texas. Both have been reported from the South Canadian River in Oklahoma. The Canadian River seems to be the southern limit of the range of H. gracilis, which occurs northward in the larger rivers of the Great Plains to southern Canada.

Among subspecies currently recognized in H. gracilis, specimens from the Canadian River can be referred to H. g. communis. Notropis girardi is endemic in the Arkansas River system and abounds in the South Canadian, North Canadian, and Cimarron Rivers in Oklahoma and the Arkansas River in Kansas.

Preliminary results of a study of possible geographic variation in N. girardi from Texas and specimens from Kansas are presented.

564. Miller, Robert Rush. 1955. AN ANNOTATED LIST OF THE AMERICAN CYPRINODONTID FISHES OF THE GENUS FUNDULUS, WITH THE DESCRIPTION OF FUNDULUS PERSIMILIS FROM YUCATAN. Occasional papers of the Mus. of Zool., Univ. of Mich., No. 568, Aug. 1, 26 pp.

More than half a century has elapsed since the publication of a general review of the cyprinodontid fishes of the genus Fundulus (Jordan and Evermann, 1896: 632-60). At that time, 92 per cent of the species that are recognized herein were known. As currently understood, Fundulus occurs primarily on the mainland of eastern North America, although it has succeeded in populating the Bermuda Islands and Cuba (other West Indian records are not acceptable) and has reached the American west coast. On the Atlantic mainland, it ranges from southern Canada to Yucatan, being replaced farther southward by Profundulus.

The majority of the species of Fundulus inhabit the lowland fresh and brackish waters of eastern

United States, but two occur along the Pacific Coast from Morro Bay, central California, to Magdalena Bay, Baja California, in salt and fresh water. The supposed occurrence of Fundulus at the tip of Baja California is an error. Two other species, F. grandissimus, and the new species described in this paper, are confined to Yucatan, Mexico. At least seven species are reported as Pleistocene or Pliocene fossils from western United States.

565. Smith, Wendell E. and Robert W. Saalfeld. 1955. STUDIES ON COLUMBIA RIVER SMELT, THALEICHTHYS PACIFICUS (RICHARDSON). Fisheries Res. Papers, Wash. Dept. of Fisheries, Vol. 1, No. 3, Feb., pp. 3-26.

Smelt landings from the Columbia River and its tributaries have in recent years been second only to those of chinook salmon. Since the inception of the fishery the presence of smelt in the Columbia has been an annual affair, but runs in the tributaries have been sporadic in occurrence. Smelt are taken by gill nets and dip nets in the Columbia River and dip nets in its tributaries. Use of the former gear ceases when fish are sufficiently available to the dip net fishery of the tributaries to supply the markets. In recent years, diver gill nets have been introduced which allow fishing during all stages of the tide in the Columbia River. The total annual commercial landings have always exceeded 1,000,000 pounds. At present the catch is limited to market demands by smelt fishermen and has shown no decline but has fluctuated violently as the market has varied.

Limited studies indicate that the young smelt go to sea immediately after hatching and feed little, if at all, in fresh water. Little is known of their ocean habits, except that they feed on plankton. Smelt originating from the Columbia River probably return as adults to that watershed to spawn but do not necessarily return to the tributary from which they were hatched. Though racial characteristics have been only briefly investigated, the erratic tributary runs lend credence to the hypothesis that the entire smelt population is composed of one homogenous unit. A water temperature of approximately 40° F. is necessary to insure upstream migration of smelt in the Columbia River to and beyond the mouth of the Cowlitz River.

Readings of several hundred otoliths indicate that Columbia River smelt spawn predominantly at three years of age though four-year fish comprise a substantial portion of the run in some years. Evidence indicates that they die after one spawning. Male fish are at least three times as abundant as females throughout the run. Spawning occurs at night principally over fine gravel or coarse sand to which the eggs attach. In 40° to 45° F. water, eggs hatch in approximately 30 to 40 days. Commercial and sport fishing gear are known to disturb the developing eggs. (A)

566. Duncan, Rea E. 1956. USE OF INFRARED RADIATION IN THE STUDY OF FISH BEHAVIOR. U. S. Fish & Wildlife Serv., Spec. Sci. Report—Fisheries No. 170, March. 16 pp.

Infrared radiation was used to observe the actions of fish in the dark. Experiments demonstrated that the behavior of fingerling silver salmon (O. kisutch) was not affected by infrared radiation. The infrared filters used did not pass wavelengths visible to an observer; the actions of the fish were observed through an infrared viewer. The fish were not attracted or repelled by steady radiation, and they did not exhibit a fright reaction to flashing radiation. The orientation pattern in still or flowing water was not affected; there was no indication that the fish could perceive the wavelengths employed. (A)

567. Greer, Kenneth R. 1955. YEARLY FOOD HABITS OF THE RIVER OTTER IN THE THOMPSON LAKES REGION, NORTHWESTERN MONTANA, AS INDICATED BY SCAT ANALYSES. Amer. Midland Nat., Vol. 54, No. 2, Oct., pp. 299-313.

Of 2,209 otter scats collected in the Thompson Lakes region of Lincoln County, Montana, between April 1952 and May 1953, 1,374 could be assigned to a winter, spring, summer, or fall deposition period; these form the basis for this food habits study. Data are expressed on percent occurrence by seasons, calculated by dividing the number of scats for a season into the number of occurrences of an item.

For the entire year and for both areas fish remains were identified most frequently, appearing in 1,280 (93.2 percent) of the scats. Invertebrates were recorded for 566 (41.2 percent), amphibians 253 (18.4 percent), mammals 84 (6.1 percent), birds 71 (5.2 percent) and reptiles 5 (0.4 percent).

Considering all scats, sunfish occurred in 58.2 percent, sucker 33.3 percent, sculpin 21.0 percent, and trout 18.5 percent.

Dragon fly numphs, aquatic beetles and fresh water shrimp appeared in scats consistently, but seldom made up an appreciable percent of the scat. It was most common to find 1-5 of these in a dropping.

Frogs were found to be a prominent part of the diet and were found throughout all seasons. Muskrat occurred in 4.4 percent of total scats but was present in 18.7 percent of the collection at Gary's lake and predominant during spring and summer. The highest incidence was in June, occurring in 14 scats. Beaver appeared in 10 or 0.7 percent of all scats with 8 occurring at Gary's and 2 for the Thompson. The data suggest availability to be important in determining the food habits of the otter.

568. Tebo, Leonidas B., Jr. 1955. BOTTOM FAUNA OF A SHALLOW EUTROPHIC LAKE, LIZARD LAKE, POCAHONTAS COUNTY, IOWA. The Amer. Midland Nat., Vol. 54, No. 1, July, pp. 89-103.

Bottom samples were collected during the period from July 9 to October 6, 1951, at two deep water stations and three shallow water stations believed to be representative of the major types of habitat in Lizard Lake. The magnitude of variation between samples was so great that any quantitative generali-

zations may be subject to a great deal of error. A statistical comparison of the Petersen, Dendy and stovepipe methods of sampling indicated that there was no appreciable difference in the quantity of bottom fauna as estimated by these samplers on a sand and gravel bottom. The number of samples required to keep the standard error within 10 percent of the mean was found to be 1,658 for the Dendy, 486 for the Ekman, 54 for the stovepipe and 19 for the Petersen.

On the basis of average dry weight of organisms the greatest quantities of bottom fauna were produced on the pulpy peat bottom in the deeper part of the lake (1,873 mg per square meter) and on the fibrous peat bottom in a heavily vegetated bay (1,846 mg per square meter). A bottom composed of sand and clay produced the lowest average quantity of bottom fauna (671 mg per square meter). A sand and gravel bottom in shallow water produced the largest numbers (4,108 per square meter) and kinds of organisms but was intermediate on the basis of average dry weight (1,297 mg per square meter), because of the small average size of the organisms represented. The peak of abundance occurred in July with the minima in September or October.

Gastropoda (36.23 percent total dry weight), Tendipedidae (19.12 percent) and Oligochaeta (17.62 percent) were the most important components of the bottom fauna at the shallow water stations, while the Tendipedidae were the most abundant and composed 93.44 percent of the total dry weight in deep water.

569. Turner, William R. 1955. FOOD HABITS OF THE BLUEGILL LEPOMIS MACROCHIRUS MACROCHIRUS (RAFINESQUE), IN EIGHTEEN KENTUCKY FARM PONDS DURING APRIL AND MAY. Trans. of the Ky. Acad. of Sci., Vol. 16, No. 4, Dec., pp. 98-101.

Stomach contents of 143 bluegills seined from 18 Kentucky farm ponds during April and May, 1953 were analyzed. The greatest volume of food for all size classes was composed of insects, with chironomid larvae comprising more than 50 percent by volume and being found in more than three fourths of the fish. Crustaceans and plants also were eaten. There is an inverse relationship between the size of the bluegill and the importance of microcrustaceans in the diet. The frequency of insect predation increases directly with bluegill size.

570. Huey, William S. 1956. NEW MEXICO BEAVER MANAGEMENT. N. M. Dept. of Game and Fish Bull. No. 4, 49 pp.

During the summer of 1955, studies were conducted to determine beaver-trout relations. Two inventories were made in each of six experimental sections of the upper Red River in Taos County. Three of these contained beaver ponds and three were undisturbed stream. Each section consisted of 50 linear yards of stream area. Four species of fish—cutthroat trout, brook trout, rainbow trout, and white suckers were present in the experimental area. The average trout population in beaver sections was 154 in June and 180 in August, as opposed to 33 in June and 47 in August for the non-beaver sections. Trout taken from the beaver ponds exhibited a slightly larger average size than those taken from non-beaver sections. Food production was significantly higher in beaver sections, and trout growth appeared to be faster in these sections.

571. Rivas, Luis Rene. 1954. A COMPARISON BETWEEN GIANT BLUEFIN TUNA (Thunnus thynnus) FROM THE STRAITS OF FLORIDA AND THE GULF OF MAINE, WITH REFERENCE TO MIGRATION AND POPULATION IDENTITY. Proc. of the Gulf and Caribbean Fisheries Inst., Nov., 17 pp.

The evidence presented in this study strongly indicates, but does not prove conclusively, that the giant bluefin tuna occurring in the Straits of Florida in the late spring migrate to the north and constitute part of the same population occurring there during the summer and early fall. Definite proof will depend on tagging information, and until fish tagged in the Straits of Florida are recovered in the north, the conclusions suggested by this study must remain tentative.

Three lines of approach to this problem followed in this study were the correlation of migratory rate and direction with time and distance traveled; the correlation of body condition with time and place of occurrence; and morphometric and meristic comparisons. Each proved mutually confirmative and supported the preliminary conclusion. If the degree of mophological dissimilarity is an index of the degree of spacial separation between two populations, then the Bahama and Nova Scotia samples cannot be assumed to represent separate units. Therefore, since these samples come from widely separated localities and the fish are absent in one place when present in the other, it must also be assumed that a migratory movement takes place between the two areas.

572. Durham, Leonard. 1956. EFFECTS OF PREDATION BY CORMORANTS AND GARS ON FISH POPULATIONS OF PONDS IN ILLINOIS. Dissertation Abstr., Vol. 16, No. 2, Feb., p. 407.

Double-crested cormorants (Phalacrocorax auritus auritus) and shortnose gars (Lepisosteus platostomus) were placed in small ponds so that the effects of these predators on the fish populations could be studied. Control ponds were also studied. Food habits of cormorants were observed in the laboratory and in the field in order to determine roughly their food requirements. The stomachs of 62 double-crested cormorants contained fish ranging in total length from 3.5 to 12.2 inches. Five cormorants in the laboratory ate an average of 0.9 pounds of fish per bird per day for 71 days.

On the basis of the above results, it appears that cormorants should be used as predators on fish populations on a short-term basis only. Shortnose gars appeared to be more practical for use in controlling fish populations than did cormorants. (A)

573. Deubler, Earl Edward, Jr. 1956. A TAXONOMIC STUDY OF THE CYPRINID FISH CLINOSTO-

MUS VANDOISULUS (VALENCIENNES) IN THE EASTERN UNITED STATES. Dissertation Abstr., Vol. 16, No. 2, Feb., p. 406.

Ichthyologists have long realized that Clinostomus vandoisulus exhibits considerable geographical variation in meristic and proportional characters; however, no complete study has determined the exact distributional pattern and the nature and significance of the geographical variation. In this study, geographical variation and distribution have been correlated in an attempt to gain a better insight into the pattern of speciation for the minnow.

Clinostomus vandoisulus is confined to that area of the United States east of the Mississippi River which is bounded approximately by the thirty-fourth and fortieth parallels of latitude. With the possible exceptions of the Cape Fear River in North Carolina and the Edisto River in South Carolina, it occurs in all major Atlantic Slope drainages from the Delaware River in southeastern Pennsylvania and western New Jersey to the Upper Savannah River in Georgia. West of the Appalachian Divide, the species is discontinuously distributed in tributaries of the Ohio River in West Virginia, Ohio, Kentucky and Tennessee. It occurs in mountainous and piedmont habitats.

Over 1900 specimens were examined throughout the range of the species. Thirty-two meristic and proportional characters were utilized. All data are presented as frequency distributions and characters which are diagnostic are presented in the form of significance diagrams. (A)

574. Gibbs, Robert Henry, Jr. 1956. A SYSTEMATIC STUDY OF THE CYPRINID FISHES BELONGING TO THE SUBGENUS CYPRINELLA OF THE GENUS NOTROPIS. Dissertation Abstr., Vol. 16, No. 2, Feb., p. 409.

In the large and diverse genus Notropis, one of the most clearly recognizable groups is the subgenus Cyprinella. In spite of the relative similarity of the species, however, their generic status has been confused, and conversely, their similarity has resulted in specific misidentification. More than 50 specific names have been applied to the members of the subgenus, and they have been included in no less than 14 genera or subgenera. The major cause of both the generic and specific vacillation has been the variability of the forms, the unwise use of which has resulted in unnatural subdividing. The present study attempts to define the subgenus Cyprinella, to elucidate its patterns of variation, to delineate and properly describe the species and their subdivisions, and to consider the dispersal and evolution of the group. (A)

575. Mossman, Archie Stanton. 1956. EXPERIMENTAL STUDIES OF FITNESS AS MEASURED BY VULNERABILITY TO PREDATION. Dissertation Abstr., Vol. 16, No. 2, Feb., pp. 410-411.

Experiments on predation selectivity in relation to the "physical fitness" of the prey were conducted utilizing known predator and prey populations. Fish served as predators on other fish, birds as predators upon birds, and mammals as predators on birds and mammals.

Usually about half of the prey animals present were chosen randomly and hampered in some manner. The relative vulnerabilities of hampered and normal animals were then tested. In general, the hampered animals were more vulnerable than the normal controls although some exceptions did occur.

Fish species possessing stout spines were made more vulnerable by removal of their spines than by removal of their main propulsive fins. On the other hand, fish lacking spines suffered a marked decrease in viability under predation after their caudal fins had been cut off.

A loss in the selectivity of predation occurred during two experiments when cover was added. If the addition of cover was indeed responsible, this confirms tentative deductions based on general observation and theory.

The relationship between cover, disturbance and predation is discussed in the light of observations made in the experiments and in the light of published records, with the conclusion that increasing disturbance of the prey should increase the vulnerability. A corollary of this relationship seems to be that predator pressure should rise faster than the number of predators, especially where a variety of predators occurs.

Fitness is defined as the level of adaptation of an organism or group of organisms to its environment. In this study, fitness has been measured by testing the vulnerability of organisms to predation. Similarly cover should be measured in relation to its ability to provide the functions expected of it, such as concealment for stalking predators or protection from predation. The term "prey protective cover" has been coined to cover the latter more effectively than the somewhat restrictive term "escape cover."

Prey and predator density in relation to predation selectivity is briefly considered.

Cyclic and eruptive behavior of animal populations is discussed and it is suggested that such phenomena may be allowed by the failure of predation to prevent prey increases. Some mechanisms of predation that help determine the amount of predator pressure are discussed. Using this information as a background it is hypothesized that cycles and eruptions should be least violent in complicated ecosystems and most violent in uncomplicated ecosystems (weather excepted). Field observations described in the literature seem to support this hypothesis. (A)

576. Woolcott, William Starnold, Jr. 1956. COMPARATIVE OSTEOLOGY OF SERRANID FISHES OF THE GENUS MORONE (MITCHILL) AND INFRASPECIFIC VARIATION IN MORONE AMERICANUS (GMELIN). Dissertation Abstr., Vol. 16, No. 2, Feb., p. 414.

The genus Morone occurs between parallels 50° N and 25° N and is represented by six species: saxatilis (Walbaum), chrysops (Rafinesque), americanus (Gmelin) and interruptus (Gill) in North America and labrax (Linnaeus) and punctatus

(Bloch) in Europe. These species were formerly assigned to as many as five genera by authors. Berg (1949, Fresh-water Fishes of the USSR and Adjoining Countries) relegated them to a single genus Morone with three sub-genera and based his classification primarily on external characters. The present osteological study, undertaken to check the validity of his conclusions, compared five species (punctatus excepted).

Preserved specimens were x-rayed, cleared and stained while others were cleaned by insects. The skeletal parts which showed greatest species differences were supraoccipital crest, otic (prootic, basioccipital and exoccipital), vomerine tooth plate and preopercle. Although smaller differences were noted in both the skull and trunk skeleton, in many cases where species differences occurred intermediate forms were found. Except for americanus and interruptus the species were readily separated using osteological characters. The findings strongly support the monogeneric classification of Berg, but both osteological and external characters are needed to properly define sub-genera.

A study of the variation pattern in americanus was made to determine whether various populations differed and if so on what level. The variation pattern was compared with that of saxatilis which occurs sympatrically over a part of the range.

Counts of fin rays and scales and measurements of various body parts were made on over 1,400 specimens. The data are presented as frequency distributions and in some instances significance diagrams are presented.

In americanus there appear to be two primary gene pools located north and south of the Delaware River. Evidence for this was found in anal ray and lateral-line scale counts which were higher in the north. Almost all measurements (expressed as percentage of standard length) were greater in the south. The Delaware River population is intermediate in many characters and appears to have drawn from both northern and southern gene pools. Partially isolated populations within the two major gene pools have diverged on a low level. Some differences are probably due to selective adaptation while others may be the result of phenotypic response to environmental influence. In lake populations the specimens were more elongate than were those from rivers. Many and often pronounced differences occurred in the composite sample from the Croton and West Branch Reservoirs which separate it from all other stocks including its parent stock in the Hudson River from which it has been separated by dams for less than 100 years.

The variation pattern in americanus is considerably different than that of saxatilis. For example in americanus fin-ray counts were generally higher in the Hudson River and lower in Chesapeake Bay tributaries whereas in saxatilis the reverse is true. The difference in the pattern of variation in these related species lends support to the belief that many differences between populations within each species may be genetic rather than due to environmental influence. (A)

577. Carlin, Börje. 1955. TAGGING OF SALMON SMOLTS IN THE RIVER LAGAN. Annl. Rep. for the Year 1954 and Short Papers, Inst. of Freshwater Res., Rep. No. 36, Fishery Bd. of Sweden, pp. 57-74.

About 17,000 salmon smolts from the salmon hatchery at Laholm were tagged before release into the River Lagan. In different experiments the proportion of recaptures ranged from 5 to 10 percent which indicates that artificial propagation of salmon in this way may be sound from the biological and economical points of view.

The recaptures make it possible to follow part of the migrations of the salmon, firstly on their outward journey as far as to the middle of the Skagerrak, and on the return journey along the coast of Norway and Sweden. No recaptures were, however, made at the main feeding grounds, the locations of which are not yet known. Of the salmon recaptured as adults, 353 out of 778 were caught on the coast in the immediate vicinity of the mouth of the Lagan and 223 in the River Lagan itself. No fish were retaken in any other river. The majority of the recaptured tagged salmon were retaken after one winter in the sea, most of the remaining after two winters and only a few after more than two winters in the sea. Results for smolts liberated directly into the sea were as good as for those released in the river. Autumn liberations resulted in a low percentage of recoveries, as was also the case when one-year-old smolts were released. The percentage of recoveries generally increased with a rise in the smolt length. There is a positive correlation between smolt size and size at recapture. (A)

578. Fabricius, Eric and Karl-Jakob Gustafson. 1955. OBSERVATIONS ON THE SPAWNING BEHAVIOUR OF THE GRAYLING, THYMALLUS THYMALLUS (L.). Annl. Rep. for the Year 1954 and Short Papers, Inst. of Freshwater Res., Rep. No. 36, Fishery Bd. of Sweden, pp. 75-103.

The spawning of grayling from Lake Storsjön in the province of Jamtland was studied in the field as well as in aquarium tanks with flowing water. Observations reported on cover threatening and fighting, the vibrating display, territorial behavior, courting and spawning, promiscuous mating, the daily rhythm of activity in spawning grayling, and some environmental factors of importance. A hypothesis on the origin of the courting tremble and the nest-digging movements in salmonid fish is also presented. Comparison is made with observed activities of other salmonids whenever appropriate.

579. Alm, Gunnar. 1955. ARTIFICIAL HYBRIDIZATION BETWEEN DIFFERENT SPECIES OF THE SALMON FAMILY. Annl. Rep. for the Year 1954 and Short Papers, Inst. of Freshwater Res., Rep. No. 36, Fishery Bd. of Sweden, pp. 13-56.

Artificial hybridization was carried out with the following species and forms of the salmon family, namely salmon (Salmo salar), sea trout (Salmo trutta trutta), brown trout (Salmo trutta including the forms lacustris and fario), char (Salvelinus

or Salmo alpinus) and brook trout (Salvelinus or Salmo fontinalis). More than 80 such experiments have been made.

In such hybridization the mortality in the eggs and alevins is greater than with intraspecific fertilization. This can be explained by poor fertilization on account of the sexual products not being fully ripe at the same time, or by mechanical impediments to the penetration of the sperm into the eggs, but chiefly by disturbances in the chromosome balance. The mortality due to disturbance of chromosome balance is less the closer the two species used for crossing are to one another systematically. It is thus least in the Char X Brook trout hybrids, median in the Salmon X Trout hybrids and greatest in the Trout X Char and Trout X Brook trout hybrids. In general, hybridization is independent of which species is the female fish. If the female fish is very small in relation to the male fish, however, hybridization is generally less successful in the one direction than in the other for the above-mentioned mechanical reasons. The hybrids have a good rate of growth, mostly intermediate between the parents but often similar to or better than the parent displaying the best rate of growth. The appearance of the hybrids has varied in the same experiment. In certain specimens the type has been intermediate, others have displayed characteristics from one or other of the parents. The Trout X Char and Trout X Brook trout hybrids have, however, had a very homogeneous colour marking consisting of a more or less marked high vermiculation on a dark ground in both the crosses in all the experiments. These hybrids thus differ very noticeably from the parents, while the Salmon X Trout hybrids and the Char X Brook trout hybrids are more reminiscent of the parents. The Salmon X Sea trout and reverse hybrids have undertaken long migrations like the Salmon on being released in the Sea. The Char X Brook trout and reverse hybrids have been hardier and easier to rear in ponds than the Char, and in addition have had a longer term of life than the Brook trout.

In all the series of hybrids a greater or smaller number of specimens has become sexually mature. The capacity to form eggs and milt capable of fertilization has, however, been in the same proportion as the mortality in the first stages. It has thus been greater the closer the crossed species were to one another systematically. In the Trout X Char and Trout X Brook trout hybrids no ripe spawn or milt could be produced at all. Intercrossing and backcrossing have only succeeded in the hybrids Char X Brook trout, but mortality in these F 2 hybrids has been greater than in the F 1 ones. The majority of the hybrids have no great value from practical points of view. They can, however, be used for certain experiments in connection with salmon hatching and rearing (Sea trout X Salmon hybrids). They can also be of some interest as curiosities for transplanting and rearing in ponds (Trout X Char and Trout X Brook trout hybrids).

Only the Char X Brook trout hybrids display such a low rate of mortality and in addition such good characteristics, that they can be recommended for rearing in ponds and releasing in lakes. These hybrids are also the only ones, which owing to their survival rate can be used for testing the value of fish culture. In nature the chances for hybridization between species of the Salmon family are for several reasons probably very small, but the opposite is the case in species of the Cyprinid family and several other freshwater fishes. (A)

580. Lindroth, Arne. 1955. DISTRIBUTION TERRITORIAL BEHAVIOUR AND MOVEMENTS OF SEA TROUT FRY IN THE RIVER INDALSÄLVEN. Annl. Rep. for the Year 1954 and Short Papers, Inst. of Freshwater Res., Rep. No. 36, Fishery Bd. of Sweden, pp. 104-119.

The sea trout (Salmo trutta trutta) fry population of the river Indalsälven was studied by electrofishing, marking experiments and stream tank observations. The trout fry was found to occupy the shallow water (0—3 dm deep) border line of the river, where the water ripples over stones and gravel. Facts are presented indicating that the trout actively drives the salmon fry away from these chosen areas. Observations in a stream tank have shown the territorial behaviour to be dependent on water velocity. This circumstance explains the field experience that trout fry are very rarely seen locked up in shore pools by falling water level — before being imprisoned they leave their territories. Marking of over 1,200 fry showed the trout parr population to be unstable, undertaking extensive horizontal movements. (A)

581. Lindroth, Arne. 1955. MERGANSERS AS SALMON AND TROUT PREDATORS IN THE RIVER INDALSÄLVEN. Annl. Rep. for the Year 1954 and Short Papers, Inst. of Freshwater Res., Rep. No. 36, Fishery Bd. of Sweden, pp. 126-132.

Stomach analysis of 23 shot Mergus merganser and 2 M. serrator show that in the river Indalsälven in northern Sweden these birds feed mainly upon salmon, trout and miller's thumb, the two former species contributing at least 50 percent of the food. A rough estimate indicates that the merganser population in 1954 may have consumed about 350,000 10-gram salmon (or trout) parr, the mean annual smolt production of the river being estimated at about 300,000 individuals. (A)

582. Müller, Von Karl. 1955. PRODUKTIONSBIOLOGISCHE UNTERSUCHUNGEN IN NORDSCHWEDISCHEN FLIESSGEWÄSSERN. (Teil: 3. Die Bedeutung der Seen und Stillwasserzonen für die Produktion in Fliessgewässern.) Annl. Rep. for the Year 1954 and Short Papers, Inst. of Freshwater Res., Rep. No. 36, Fishery Bd. of Sweden, pp. 149-162. (Text is in German)

The present work deals with the influence of lakes on a river. It is characteristic for Scandinavian streams—here demonstrated on the River Luleälv as an example — that a river is running through several lakes in its course. In this way, an interchange of influence arises, the river having effect upon the lake and vice versa. The lakes do not appear at the lower part of the streams, where they are replaced by broad, slow flowing still water zones (Swedish "sel") up to 60 kilom-

etres long. This investigation was mainly concentrated on the qualitative and quantitative composition of the bentic fauna in the rapids below the lakes. It proved to be a characteristic trait in these rapids that the amount and number of "passive forms of feeders" are by far the most predominant part. Here, the net-making species of Trichoptera (Hydropsyche, Neureclipsis, Plectrocnemia), Simulium and Orthocladinae-larvae are prevailing. Investigations on the nutrition of these larvae showed that they are almost exclusively restricted to feeding on the Phyto- and Zooplankton, which drift out of the lake into the river. On this account, the amount of the larvae always depends on the production of plankton in the lake lying above the rapids. Naturally, the amount of "passive" forms decreases with increasing distance to the lake. Under the same conditions, however, the different forms of "active feeders" (Ephemeroptera, Plecoptera, various Trichoptera, various Chironomidae) proved to be very constant as to the amount in which they appeared. The population of bentic animals in the river systems lacking lakes is almost completely derived from "the active feeders" and, therefore, the abundance is mostly very small. Two rivers in Middle Sweden are shown to present almost equal quantities of "active" forms, but the River Tandsjoan located below a lake has, in addition, an extensive population of passive feeding species of larvae. Various observations show that young fish (Salmo trutta) as well make alimentary use of the plankton drifting out of the lake into the river. The typical biocenoses of the outflows of the lakes, established in various Swedish river systems do not appear below regulated parts of lakes and rivers. The amount of "active feeders" always predominates over the passive. The "Capacite biogenique" (in the sense given by Huet) is in this way through an act of interference (building of power plants) always very insignificant. The reason for this is to be found in the fact, that cold, alimentarily poor water is led from the depth of the power dam into the river. The occurrence of "passive feeders" is hereby excluded. Investigations are going on as to the amount and composition of the organic drift received by rivers from natural and regulated lakes. (A)

583. Gangmark, Harold A. and Robert D. Broad. 1955. EXPERIMENTAL HATCHING OF KING SALMON IN MILL CREEK, A TRIBUTARY OF THE SACRAMENTO RIVER. Calif. Fish & Game, Vol. 41, No. 3, July, pp. 233-242.

One hundred plastic mesh sacks of 100 eggs of king salmon per sack, planted at random in the stream bed in October 1952, were removed 20 at a time at approximately equal intervals up to hatching stage to determine when mortalities occurred. Temperatures and stream flows were recorded and other pertinent information was noted. Water flow was stable during the period when the first three groups of eggs were in the stream. The survival rates of these groups were not significantly different. Between the times of the third and fourth removals, however, stream flow reached a maximum of 1,250 c.f.s. The average egg survival in the fourth group was less than half the survival of the third group. The increased mortality was attributed to erosion and silting.

High water conditions during January and February delayed removal of the last group of eggs. When the stream subsided, less than one-third of this group of sacks was found. Complete mortality had occurred during this period when the water flows had exceeded 5,000 c.f.s. The influence of position on the survival of eggs was tested and found to be not significant. Water temperatures remained well within the critical limits for salmon eggs during the entire course of the experiment. Although the information available from this experiment is not conclusive, it does suggest a direct relationship between floods and mortalities of king salmon eggs.

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